TABLE 4-25 (Cont'd)

SUMMARY OF PRIORITY POLLUTANT ANALYSES FOR PARAMETERS WITH QUANTITATED CONCENTRATIONS

Parameter	Samples with Quantitated Concentrations	Concentration (in mg/l)	Remarks
Methylene Chloride	PW-1C	0.090	Total concentration of all other halomethanes in all samples was 750 mg/l of which 718 mg/l was dichloromethane (methylene chloride). It is expected that the methylene chloride is a result of laboratory contamination. Not considered to be a significant problem.
	PW-2C	0.230	
	PW-3C	0.038	
	PW-4C	0.028	
	PW-5C	0.060	
	PW-6C	0.062	
	PW-7C	0.056	
	PW-8C	0.054	
	PW-9C	0.058	
	PW-10C	0.018	
	PW-11C	0.024	
Methyl Chloride	PW-1C	0.012	
Dichlorobromomethane	PW-1C	0.010	
Chlorodibromomethane	PW-1C	0.010	
Hexachlorobutadiene	PW-1C	0.016	No known source. Not considered to be a problem.
Phenol	PW-2C	0.029	No known source. Not considered to be a problem.
Phthalate Esters			
Bis(2-ethylhexyl)phthalate	PW-4C	0.017	No known specific source. Not considered to be a problem.

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tion with seven of these parameters being found at monitoring station P-1. With the exception of antimony at station P-6, all the other parameters were detected in the downgradient monitoring stations along the Hylebos Waterway. The absence of definable on-site wastestreams or production use for most of these isolated parameters and the typically very low concentrations indicate that no significant problems would exist with these constituents. Several of the organic parameters such as carbon tetrachloride, tetrachloroethylene, methyl chloride, dichlorobromomethane, and chlorodibromomethane are thought to be by-products associated with chloroform generated in the old graphite cells by the reaction of linseed oil and chlorine.

The presence of such constituents as the chlorinated ethanes, hexachlorobutadiene, phenol, bis(2-ethylhexyl)phthalate, and toluene are not attributable to any one definable on-site wastestream. It is possible that some of these constituents might be associated with very small quantities of solvents or degreasing agents that might have been periodically discharged to Taylor Lake. The presence of methylene chloride in all composited samples at very similar concentration levels indicates that its presence is possibly due to laboratory contamination.

Those parameters detected in the composited samples that can be correlated to known current or past waste management practices include chloroform, arsenic, chromium, and antimony. Of these four parameters, antimony was detected at only monitoring station P-6 which is located downgradient of the old Penite disposal area. The very low concentration (.028 mg/l) detected at this single station from the composited sample indicates that there is no significant problem associated with antimony of the facility.

The highest concentrations detected in the composited groundwater samples were for the parameter chloroform. A concentration of 1.8 mg/l was detected at station P-2 with a concentration of 1.3 mg/l being detected at station P-1. Significantly lower concentrations of 0.170 and 0.160 mg/l were detected at stations P-3 and P-4, respectively. The relatively high concentrations of chloroform at the monitoring stations downgradient of Taylor Lake can be attributed to past wastestreams (old graphite cells) that were discharged to this area. In addition, monitoring well P-1S is screened through both the shallow and intermediate zones which is probably a contributing factor to the high concentrations detected in this well. The lower concentrations of chloroform detected at stations P-3 and P-4 as well as the trace concentrations detected at the other monitoring stations is thought to be the result of the chemical reaction between the available free chlorine in the plant wastestreams and the underlying naturally-occurring organic materials in the upper peat layer.

Arsenic and chromium were detected in quantitated concentrations at most of the monitoring stations in the composited samples. The highest arsenic concentrations were detected at stations P-2 and P-6 at values of 0.470 and 0.220 mg/l, respectively. These concentrations are expected to be associated with the old Penite disposal area which is located upgradient of these monitoring stations. Based upon leaching tests performed on the on-site ASARCO sands, it is not believed that these sands are a major contributing source of arsenic. Chromium was found to be present at the highest concentration (.680 mg/l) at station P-1. The presence of chromium at this station can be attributed to discharges from the chlorate production facilities between 1978 and 1979.

Cyanide was detected at all stations except P-3 with the maximum concentration of 0.450 mg/l being detected at station P-9. The concentration distribution of cyanide in the composite samples tentatively indicates an off-site source of cyanide. There are no known on-site sources of cyanide at the Pennwalt facility.

4.8.5 First Round Results (Limited Parameters)

With the exception of selenium and bromoform, quantitated concentrations of all limited parameters were detected in at least one groundwater monitoring well. A summary of the limited parameters with quantitated concentrations is provided in Table 4-26. Of the total 22 parameters analyzed, several parameters including copper, nickel, cadmium, lead, zinc, silver, and mercury were found to be present in very low concentrations. There were no discernible concentration distributions observed for these parameters which would indicate either an on-site or off-site source of these constituents.

All samples from each of the groundwater monitoring wells contained quantitated concentrations of chloride, sodium, calcium, and magnesium. The presence of these constituents in the groundwater was expected due to the presence of on-site waste and raw materials as well as the potential for influence from the waterway. All samples from the intermediate zone contained levels of chloride in excess of 1,500 mg/l, with the higher concentrations being found in wells nearest the waterway. Very high

TABLE 4-26

SUMMARY OF LIMITED PARAMETER ANALYSES FOR PARAMETERS WITH QUANTITATED CONCENTRATIONS

Parameter	Samples with Quantitated Concentrations	Concentration (in mg/l)	Remarks
Antimony	PW-6S-HT	0.050	Antimony contained in raw materials for Penite production. Not considered to be a significant problem.
	PW-6S-LT	0.030	
	PW-6D-HT	0.020	
	PW-6D-LT	0.050	
Arsenic	PW-1S-HT	0.070	Concentration distribution indicates that ASARCO sands as well as the old Penite area are contributors of arsenic. Not considered to be a significant problem.
	PW-2S-HT	0.240	
	PW-3S-HT	0.080	
	PW-5S-HT	0.040	
	PW-6S-HT	0.100	
	PW-8S-HT	0.010	
	PW-1S-LT	0.020	
	PW-2S-LT	0.440	
	PW-3S-LT	0.060	
	PW-5S-LT	0.040	
	PW-6S-LT	0.520	
	PW-6D-HT	0.420	
	PW-9D-HT	0.030	
	PW-6D-LT	0.800	
Barium	PW-3S-HT	0.400	Concentration distribution indicates salt from salt storage area is probable source of barium. Not considered to be a significant problem.
	PW-4S-HT	0.800	
	PW-6S-HT	0.300	
	PW-11S-HT	0.800	
	PW-3S-LT	0.900	
	PW-4S-LT	0.800	
	PW-8S-LT	0.300	
	PW-11S-LT	1.100	
	PW-4D-HT	0.400	

TABLE 4-26 (Cont'd)

SUMMARY OF LIMITED PARAMETER ANALYSES FOR PARAMETERS WITH QUANTITATED CONCENTRATIONS

Parameter	Samples with Quantitated Concentrations	Concentration (in mg/l)	Remarks
Copper	PW-1S-HT	0.019	No significant concentration distribution to indicate an on-site source. Not considered to be a problem.
	PW-2S-HT	0.023	
	PW-3S-HT	0.014	
	PW-4S-HT	0.016	
	PW-5S-HT	0.015	
	PW-6S-HT	0.016	
	PW-8S-HT	0.011	
	PW-9S-HT	0.013	
	PW-10S-HT	0.006	
	PW-11S-HT	0.031	
	PW-1S-LT	0.018	
	PW-2S-LT	0.029	
	PW-3S-LT	0.017	
	PW-5S-LT	0.004	
	PW-9D-HT	0.024	
	PW-10D-HT	0.015	
	PW-1D-LT	0.008	
	PW-2D-LT	0.011	
	PW-3D-LT	0.012	
	PW-4D-LT	0.044	
	PW-5D-LT	0.014	
	PW-6D-LT	0.022	
	PW-7D-LT	0.007	
	PW-8D-LT	0.009	
	PW-9D-LT	0.008	
	PW-10D-LT	0.009	

TABLE 4-26 (Cont'd)

SUMMARY OF LIMITED PARAMETER ANALYSES FOR PARAMETERS WITH QUANTITATED CONCENTRATIONS

Parameter	Samples with Quantitated Concentrations	Concentration (in mg/l)	Remarks
Nickel	PW-1S-HT	0.019	No significant concentration distribution to indicate an on-site source. Not considered to be a problem.
	PW-2S-HT	0.032	
	PW-3S-HT	0.010	
	PW-4S-HT	0.014	
	PW-5S-HT	0.027	
	PW-6S-HT	0.023	
	PW-9S-HT	0.020	
	PW-10S-HT	0.008	
	PW-2S-LT	0.009	
	PW-3S-LT	0.006	
	PW-4S-LT	0.009	
	PW-5S-LT	0.031	
	PW-9S-LT	0.025	
	PW-4D-HT	0.005	
	PW-7D-HT	0.010	
	PW-9D-HT	0.006	
	PW-2D-LT	0.008	
	PW-3D-LT	0.008	
	PW-4D-LT	0.005	
	PW-5D-LT	0.005	
	PW-6D-LT	0.009	
Cadmium	PW-6S-HT	0.007	No significant concentration distribution to indicate an on-site source. Not considered to be a problem.
	PW-9S-HT	0.011	
	PW-1S-LT	0.006	
	PW-11S-LT	0.002	
	PW-1D-HT	0.007	
	PW-9D-HT	0.010	

TABLE 4-26 (Cont'd)

SUMMARY OF LIMITED PARAMETER ANALYSES FOR PARAMETERS WITH QUANTITATED CONCENTRATIONS

Parameter	Samples with Quantitated Concentrations	Concentration (in mg/l)	Remarks
Cadmium, continued	PW-10D-HT	0.013	
	PW-5D-LT	0.011	
	PW-7D-LT	0.015	
	PW-10D-LT	0.006	
Lead	PW-35-LT	0.005	No significant concentration distribution to indicate an on-site source. Not considered to be a problem.
	PW-6D-HT	0.005	
	PW-9D-HT	0.007	
	PW-10D-HT	0.005	
	PW-4D-LT	0.010	
	PW-6D-LT	0.012	
	PW-10D-LT	0.005	
Zinc	PW-1S-HT	0.002	No significant concentration distribution to indicate an on-site source. Not considered to be a problem.
	PW-2S-HT	0.032	
	PW-3S-HT	0.006	
	PW-4S-HT	0.010	
	PW-7S-HT	0.002	
	PW-8S-HT	0.008	
	PW-9S-HT	0.010	
	PW-10S-HT	0.004	
	PW-11S-HT	0.002	
	PW-1S-LT	0.007	
	PW-3S-LT	0.012	
	PS-4S-LT	0.030	
	PS-6S-LT	0.009	
	PS-7S-LT	0.016	

TABLE 4-26 (Cont'd)

SUMMARY OF LIMITED PARAMETER ANALYSES FOR PARAMETERS WITH QUANTITATED CONCENTRATIONS

Parameter	Samples with Quantitated Concentrations	Concentration (in mg/l)	Remarks
Zinc, continued	PW-8S-LT	0.013	
	PW-9S-LT	0.015	
	PW-10S-LT	0.003	
	PW-11S-LT	0.009	
	PW-9D-HT	0.010	
	PW-10D-HT	0.005	
	PW-2D-LT	0.003	
	PW-3D-LT	0.011	
	PW-5D-LT	0.005	
	PW-6D-LT	0.021	
	PW-7D-LT	0.005	
	PW-8D-LT	0.003	
	PW-9D-LT	0.003	
	PW-10D-LT	0.012	
Silver	PW-1S-HT	0.003	No significant concentration distribution to indicate an on-site source. Not considered to be a problem.
	PS-2S-HT	0.004	
	PW-3S-HT	0.002	
	PW-4S-HT	0.002	
	PW-2S-LT	0.005	
	PW-6D-HT	0.003	
	PW-10D-HT	0.005	
	PW-9D-LT	0.002	
Mercury	PW-7S-HT	0.007	No significant concentration distribution to indicate an on-site source. Not considered to be a problem.
	PW-8S-HT	0.006	
	PW-9S-HT	0.002	
	PW-10S-HT	0.004	

TABLE 4.26 (Cont'd)

SUMMARY OF LIMITED PARAMETER ANALYSES FOR PARAMETERS WITH QUANTITATED CONCENTRATIONS

Parameter	Samples with Quantitated Concentrations	Concentration (in mg/l)	Remarks
Mercury, continued	PW-7S-LT	0.008	
	PW-1D-HT	0.004	
	PW-6D-HT	0.003	
	PW-1D-LT	0.004	
	PW-3D-LT	0.002	
	PW-6D-LT	0.007	
	PW-8D-LT	0.003	
Chromium (Total)	PW-1S-LT	0.044	Maximum detected concentration of 1,100 g/l in sample PW-1S-LT. This value appears somewhat anomolous since concentration in sample PW-1S-HT was 44 g/l. Minor amounts of chromium were discharged to lagoons between 1978 and 1979 from chlorate production. Not considered to be a significant problem.
	PW-3S-LT	0.009	
	PW-5S-LT	0.013	
	PW-8S-LT	0.018	
	PW-9S-LT	0.008	
	PW-10S-LT	0.012	
	PW-1S-HT	1.100	
	PW-2S-HT	0.012	
	PW-5S-HT	0.016	
	PW-8S-HT	0.006	
	PW-10S-HT	0.007	
	PW-1D-HT	0.022	
	PW-2D-HT	0.011	
	PW-3D-HT	0.005	
	PW-4D-HT	0.005	
	PW-5D-HT	0.009	
	PW-9D-HT	0.031	
	PW-10D-HT	0.005	
	PW-3D-LT	0.006	
	PW-4D-LT	0.019	

TABLE 4-26 (Cont'd)

SUMMARY OF LIMITED PARAMETER ANALYSES FOR PARAMETERS WITH QUANTITATED CONCENTRATIONS

Parameter	Samples with Quantitated Concentrations	Concentration (in mg/l)	Remarks
Chromium (Total), continued	PW-5D-LT	0.011	
	PW-6D-LT	0.005	
	PW-8D-LT	0.005	
	PW-9D-LT	0.016	
	PW-10D-LT	0.005	
Chromium (Hexavalent)	PW-1S-HT	0.040	Not considered to be a problem.
	PW-7D-HT	0.010	
Chloride	All Samples	Refer to Tables 1 & 2	All shallow well samples show chloride levels greater than 1,000 mg/l, with the highest concentrations found nearest the waterway. All the deep well samples have chloride concentrations less than 500 mg/l, with the exceptions of 4D-HT (30,600 mg/l) and 4D-LT (47,000 mg/l). These extremely high concentrations are indicative of probable contamination from the salt storage area. Not considered to be a significant problem.

TABLE 4-26 (Cont'd)

SUMMARY OF LIMITED PARAMETER ANALYSES FOR PARAMETERS WITH QUANTITATED CONCENTRATIONS

Parameter	Samples with Quantitated Concentrations	Concentration (in mg/l)	Remarks
Sodium, Calcium, & Magnesium	All Samples	Refer to Tables 1 & 2	All shallow well samples have high concentrations of these ions. Probable sources are: 1) residual contamination from dredged fill material, 2) inflow from waterways, and 3) seepage from lagoons and salt storage areas. Wells 1S and 2S show what is possibly an ion exchange phenomenon causing the low concentrations of Ca and Mg. The deep wells have much lower concentrations of these ions (range from 11 to 93 mg/l), with the exception of Well 4D. Very high levels of sodium and high levels of Ca and Mg indicate probable seepage from the salt storage area. These high levels of concentrations correlate with the high concentration of chlorides in Well 4D. Not considered to be a significant problem.
Halomethanes Chloroform	PW-1S-HT	14.000	All shallow and deep samples with the exceptions of PW-7S-HT and PW-3D-HT contained at least a trace of chloroform. Concentrations of chloroform in the vicinity of the lagoons can be attributed to past waste generation and disposal practices. Lower concentrations of halomethanes detected in other wells might
	PW-2S-HT	10.000	
	PW-3S-HT	0.830	
	PW-4S-HT	0.230	
	PW-5S-HT	0.012	
	PW-10S-HT	0.015	
	PW-1S-LT	5.400	
	PW-2S-LT	5.700	

TABLE 4-26 (Cont'd)

SUMMARY OF LIMITED PARAMETER ANALYSES FOR PARAMETERS WITH QUANTITATED CONCENTRATIONS

Parameter	Samples with Quantitated Concentrations	Concentration (in mg/l)	Remarks
Chloroform, continued	PW-3S-LT	0.470	be the result of the chemical reaction between free chlorine and buried naturally-occurring organic materials.
	PW-4S-LT	0.160	
	PW-6S-LT	0.010	
	PW-7S-LT	0.010	
	PW-8S-LT	0.011	
	PW-9S-LT	0.010	
	PW-11S-LT	0.011	
	PW-1D-HT	0.053	
	PW-4D-HT	0.073	
	PW-8D-HT	0.012	
	PW-9D-HT	0.017	
	PW-10D-HT	0.018	
	PW-1D-LT	0.065	
	PW-4D-LT	0.170	
	PW-10D-LT	0.015	
Dichlorobromomethane	PW-1S-HT	0.020	
	PW-1S-LT	0.070	
Dibromochloromethane	PW-1S-HT	0.016	
	PW-1S-LT	0.100	
Carbon Tetrachloride	PW-1S-HT	0.830	No known specific source. Might be a byproduct along with chloroform generated in old graphite cells by the reaction of linseed oil and chlorine. Not considered to be a significant problem.
	PW-2S-HT	0.013	
	PW-1S-LT	1.200	

chloride concentrations were detected in monitoring wells P-4S (27,300 mg/l), P-11S (35,000 mg/l), and P-5S (36,500 mg/l). Monitoring stations P-4 and P-11 are being influenced by leakage from the salt storage pads, whereas, it is thought that P-5S is influenced by past leakage of wastes from Taylor Lake in the area of monitoring station P-5. With the exception of monitoring well P-4D, all samples from the deep zone revealed chloride concentrations of less than 500 mg/l. This indicates that with the exception of the area in the vicinity of the salt storage area chlorides are not migrating into the deeper zone at this time but are being transported primarily through the intermediate zone. Slightly elevated chloride concentrations were detected in monitoring wells P-1D and P-6D which indicates some limited vertical migration to the deep zone in these areas. In the area of the salt storage, it is very likely that a density-controlled plume has developed beneath this area with subsequent lateral migration occurring through the intermediate zone along the top of the lower confining layer and through the deep zone along the top of an underlying confining (silt/clay) unit. There were no apparent trends in chloride concentrations between high and low tides. As expected, sodium showed concentration distributions and fluctuations similar to those of chloride with a few exceptions.

Calcium and magnesium also showed a similar concentration distribution to chloride; however, detected concentrations were significantly lower with the highest magnesium and calcium concentrations being detected in monitoring well P-4S at levels of 810 mg/l and 460 mg/l, respectively. The presence of magnesium and calcium in the groundwater can be attributable to the same sources as identified for chloride and sodium.

Barium was detected in five of the intermediate monitoring wells and in monitoring well P-4D with the highest concentration, 1.1 mg/l, being detected in monitoring well P-11S. The concentration distribution of barium indicates that the salt storage area and the chlorate pond (brine sludge) are source areas of the barium. Barium is a common constituent of salt and, therefore, these concentrations are not unexpected. The presence of barium in monitoring well P-4D indicates that barium is migrating vertically through the upper confining layers as part of the high density plume of sodium chloride from the salt storage area.

Antimony was detected in quantitated concentrations in only those samples from monitoring well P-6S and P-6D at concentrations of only 0.02 to 0.05 mg/l respectively. The presence of antimony at monitoring station PW-6 is thought to be due to small amounts of antimony that were contained in the raw materials for Penite production. Since monitoring station PW-6 is downgradient of the old Penite disposal area, these concentrations are not unexpected. However, the very low concentrations encountered and the absence of antimony in any other monitoring wells indicate that this constituent is not a significant problem at this time.

Arsenic was detected in quantitated concentrations in only six intermediate wells and two deep wells with the highest arsenic concentrations being found in monitoring wells P-2S, P-6S, and P-6D at levels of 0.440, 0.520, and 0.08 mg/l, respectively. Based upon the observed concentration distribution, the most probable source of the arsenic is the old Penite (sodium arsenite) disposal area. Early evaluations included the on-site ASARCO sands as a potential source of arsenic; however, an EP toxicity test performed on these sand revealed no quantifiable arsenic available for leaching. However, the presence of high arsenic concentrations in both monitoring wells P-2S and P-6S cannot be correlated with the expected groundwater flow path from the old Penite area. The movement of groundwater in the intermediate zone from the identified Penite disposal area has been established to be essentially north during low tide which would not intercept monitoring well P-2S (Figure 4-15). Temporary reversals in groundwater flow associated with tidal fluctuations might be responsible for some lateral dispersion; however, similar concentrations would be expected in monitoring well P-3 and probably P-1S if this were the case. Therefore, it is possible that an additional arsenic source is present in the area of Taylor Lake. In addition, it is also possible that arsenic is migrating through the shallow surficial zone and is entering the intermediate zone via a breach or higher permeability zone in the underlying confining layer. The presence of arsenic in well P-6D shows that limited vertical migration into the deeper zone has occurred; however, no arsenic was detected in any other deep monitoring well which indicates that the arsenic plume within the deep zone has a very limited areal distribution.

Chromium was detected in most intermediate and deep monitoring wells at the facility with monitoring well P-1S having the highest levels of chromium. Hexavalent chromium was detected in only monitoring well P-1S at a concentration of 0.040 mg/l. The presence of the relatively high chromium concentrations is to be expected since this well is screened over both the shallow and intermediate zones. It is expected that the high concentrations detected are a result of contributions from the shallow zone rather than the intermediate zone. This is substantiated by the low chromium concentrations detected in the other monitoring wells tapping the intermediate zone. The source of chromium in the intermediate zone would be expected to be the Chlorate Pond which received limited quantities of dichromate between 1978 and 1979. Chromium concentrations in the deep zone do not indicate a singular, identifiable source area.

Quantitated concentrations of chloroform were detected in all of the intermediate zone monitoring wells and five of the deep zone monitoring wells. At least a trace of chloroform was detected in all of the remaining deep wells. The highest concentrations of chloroform were detected in monitoring wells P-1S and P-2S at levels of 14,000 and 10,000 mg/l respectively. Considerably lower concentrations of 0.830 and 0.230 mg/l were detected in downgradient monitoring wells P-3S and P-4S, respectively. Concentrations in the deep wells ranged from 0.012 mg/l in well P-8D to 0.170 mg/l in P-4D. The relatively high chloroform concentrations in wells downgradient of Taylor Lake can be attributed to the past disposal of old graphite anode cells in the Graphite Cell Pond. The highest chloroform concentration being detected in well P-1S can be partly attributable to the screened interval overlapping both the shallow and intermediate zones resulting in direct inflow of chloroform from the shallow zone. The lower concentrations of chloroform, as well as dichlorobromomethane and dibromochloromethane, are thought to be the result of the chemical reaction between free chlorine that has been discharged to Taylor Lake and Waggoners Wallow and the underlying naturally-occurring organic deposits.

Carbon tetrachloride was detected in monitoring wells P-1S at high and low tides at levels of 0.830 and 1.200 mg/l, respectively. It was also detected in well P-2S at high tide at a level of 0.013 mg/l. The isolated high concentration encountered in well P-1S is thought to be due to the overlapping screening interval for this well which would permit direct inflow from the shallow zone. There are no known on-site sources of carbon tetrachloride. However, its presence might be attributable to waste solvents that might have been periodically discharged to Taylor Lake in very small quantities. The carbon tetrachloride might also be a by-product associated with chloroform generated in the old graphite cells by the reaction of linseed oil and chlorine.

4.8.6 Second Round Results

The analytical results of the second round groundwater samples collected on July 2, 1981, revealed similar concentration distributions as detected in the first round results with concentrations of arsenic, chromium, and hexavalent chromium being detected in somewhat higher concentrations in this round for the intermediate zone wells, and chloroform and carbon tetrachloride being detected in somewhat lower concentrations in the intermediate zone wells (Table 4-16). The samples from the deep zone monitoring wells showed very few quantitated concentrations of the analyzed parameters with typically lower concentrations being detected where quantifiable concentrations were present (Table 4-17).

Cyanide was analyzed in the second round groundwater samples as a result of its presence in the composited priority pollutant samples from the first round sampling program. The concentrations detected and the distribution pattern evident from these second round results are similar to those found from the priority pollutant analyses with the highest cyanide concentrations of 1.37 and 0.947 mg/l being found in samples PW-9S-HT and PW-9S-LT, respectively. Significantly lower concentrations, less than 0.099 mg/l, were detected in samples from the remaining intermediate zone monitoring wells with the exception of well P-3S where cyanide was not detected. Only very small, trace quantities (less than 0.008 mg/l) of cyanide were detected in six of the deep zone monitoring wells. The concentration distribution indicated by the second round results tends to confirm the presence of an off-site source of cyanide located upgradient of monitoring station P-9.

With the exception of monitoring well P-6S, all the intermediate zone wells contained measurable concentrations of total chromium with samples PW-1S-HT and PW-1S-LT having the highest chromium concentrations of 1.34 and 1.19 mg/l, respectively (Table 4-16). Monitoring well P-2S contained the next highest levels of total chromium with the remaining samples from intermediate zone monitoring wells having concentrations less than 0.049 mg/l. Hexavalent chromium was detected in only monitoring wells P-1S and P-2S with the highest level of 1.11 mg/l being present in sample PW-1S-HT. The presence of the relatively high total and hexavalent chromium levels in well P-1S is to be expected since this well is screen over both the surficial and intermediate zones resulting in a direct influence from the surficial zone. The chromium concentrations detected in the second round samples verify a limited areal distribution for elevated chromium levels in the intermediate zone which can be correlated to the known limited discharge of a dichromate wastestream to the Chlorate Pond between 1978 and 1979. Quantitated concentrations of total chromium were detected in only deep zone monitoring wells P-4D, P-7D, P-8D, and P-9D with the highest concentrations being detected in the background wells P-7D and P-9D.

Arsenic was detected in most of the second round samples from the intermediate zone wells with significantly higher arsenic concentrations (2.3 and 7.3 mg/l) being detected in well P-2S (Table 4-16). Monitoring well P-6S contained the next highest arsenic concentrations at levels of 0.22 and 0.20 mg/l in samples PW-6S-LT and PW-6S-HT, respectively. Concentrations in the remaining intermediate zone samples were all less than 0.08 mg/l. The concentration distribution of arsenic is similar to that which was detected in the first round sampling program with the most likely source of the arsenic being the old Penite (sodium arsenite) dispoal area. However, the significantly higher arsenic concentrations in well P-2S can not be directly correlated to the Penite disposal area based upon expected groundwater movement in this area (Figure 4-15). The transient, temporary reversals in groundwater flow in the intermediate zone as a result of tidal fluctuations might be responsible for some lateral dispersion; however, similar arsenic concentrations would be expected in monitoring well P-3S if this were the situation. It is possible that an additional arsenic source is present in the Taylor Lake area: however, the ASARCO sands were found to contain no readily available arsenic based upon EP toxicity tests. Another possibility is that arsenic is migrating through the shallow surficial zone and is entering the intermediate zone via a breach or higher permeability zone in the underlying confining layer. As in the previous sampling round, arsenic was detected in the deep zone at monitoring station P-6 which indicates some limited vertical migration of the arsenic into the deep zone. Very low arsenic concentrations were also detected in deep wells P-4D, P-7D, and P-10D.

Substantially lower concentrations of volatile organics were detected in most of the second round groundwater samples as compared to the first round samples (Table 4-27). Quantitated concentrations of chloroform were detected in wells P-1S, P-2S, P-3S, P-4S, P-5S, and P-6S with the highest chloroform concentrations being detected in samples PW-2S-HT and PW-1S-LT at values of 5.840 and 3.050 mg/l. Considerably lower concentrations, less than 0.390 mg/l, were detected in the other intermediate zone wells. Chloroform was also detected in deep zone monitoring wells P-1D, P-4D, P-5D, and P-10D with the highest levels being detected in well P-4D (0.310 and 0.068 mg/l). Concentrations in the remaining deep wells were less than 0.019 mg/l. The concentration distribution of chloroform is similar to that observed from the first round samples with the source of chloroform most likely being the Graphite Cell Pond where old graphite anode cells were once disposed. The lower chloroform concentrations detected in intermediate zone wells away from the Graphite Cell Pond as well as the deep zone wells might be attributable to the chemical reaction between free chlorine that has been discharge to Taylor Lake and Waggoners Wallow and the underlying naturally occurring organic deposits.

Carbon tetrachloride was detected in intermediate zone wells P-1S and P-2S at concentrations ranging from 0.005 to 0.062 mg/l (Table 4-28).

TABLE 4-27

COMPARISON OF FIRST AND SECOND ROUND
ANALYTICAL RESULTS FOR DEEP
MONITORING WELLS AT HIGH AND LOW TIDES

Monitoring Well	Parameter (in mg/l)				
	pH	Arsenic	Hexavalent Chromium	Total Chromium	Total Cyanide
PW-1D-LT	NA/ 7.85	< 0.01/ <0.03	<0.01/ < 0.010	< 0.005/ <0.010	NA/ < 0.003
PW-1D-HT	NA/ 7.90	< 0.01/ <0.03	<0.01/ < 0.010	0.022/ <0.010	NA/ 0.008
PW-2D-LT	NA/ 7.55	< 0.01/ <0.03	<0.01/ < 0.010	< 0.005/ <0.010	NA/ < 0.003
PW-2D-HT	NA/ 7.55	< 0.01/ <0.03	<0.01/ < 0.010	0.011/ <0.010	NA/ < 0.003
PW-3D-LT	NA/ 7.35	< 0.01/ <0.03	<0.01/ < 0.010	0.006/ <0.010	NA/ 0.004
PW-3D-HT	NA/ 7.25	< 0.01/ <0.03	<0.01/ < 0.010	0.005/ <0.010	NA/ < 0.003
PW-4D-LT	NA/ 9.95	< 0.01/ <0.03	<0.01/ < 0.010	0.019/ 0.013	NA/ 0.005
PW-4D-HT	NA/ 9.85	< 0.01/ 0.03	<0.01/ < 0.010	0.005/ 0.013	NA/ 0.005
PW-5D-LT	NA/ 8.70	< 0.01/ <0.03	<0.01/ < 0.010	0.011/ <0.010	NA/ < 0.003
PW-5D-HT	NA/ 8.15	< 0.01/ <0.03	<0.01/ < 0.010	0.009/ <0.010	NA/ 0.004
PW-6D-LT	NA/ 7.85	0.80/ 0.27	<0.01/ < 0.010	0.005/ <0.010	NA/ < 0.003
PW-6D-HT	NA/ 8.20	0.42/ 0.19	<0.01/ < 0.010	< 0.005/ <0.010	NA/ < 0.003
PW-7D-LT	NA/ 7.75	< 0.01/ <0.03	<0.01/ < 0.010	< 0.005/ <0.010	NA/ < 0.003
PW-7D-HT	NA/ 8.00	< 0.01/ 0.04	<0.01/ < 0.010	< 0.005/ 0.017	NA/ < 0.003
PW-8D-LT	NA/ 8.30	< 0.01/ <0.03	<0.01/ < 0.010	0.005/ <0.010	NA/ 0.005
PW-8D-HT	NA/ 8.35	< 0.01/ <0.03	<0.01/ < 0.010	< 0.005/ 0.011	NA/ 0.005
PW-9D-LT	NA/ 7.75	< 0.01/ <0.03	<0.01/ < 0.010	0.016/ 0.010	NA/ < 0.003
PW-9D-HT	NA/ 8.00	0.03/ <0.03	<0.01/ < 0.010	0.031/ 0.035	NA/ < 0.003
PW-10D-LT	NA/ 7.60	< 0.01/ <0.03	<0.01/ < 0.010	0.005/ <0.010	NA/ < 0.003
PW-10D-HT	NA/ 8.10	< 0.01/ 0.10	<0.01/ < 0.010	0.005/ <0.010	NA/ 0.004

TABLE 4-27 (Cont'd)

COMPARISON OF FIRST AND SECOND ROUND
ANALYTICAL RESULTS FOR DEEP
MONITORING WELLS AT HIGH AND LOW TIDES

Monitoring Well	Parameter (in mg/l) Chloro-form	Carbon Tetra-chloride	Tetrachloro-ethylene	1,1 Dichloro-ethane	1,2 Dichloro-ethane
PW-1D-LT	0.065/ 0.019	ND/< 0.00001	NA/ NA	NA/< 0.00001	NA/< 0.00001
PW-1D-HT	0.053/ 0.0079	ND/< 0.00001	NA/ NA	NA/< 0.00001	NA/< 0.00001
PW-2D-LT	tr/ <0.002	ND/< 0.00001	NA/ 0.0009		
PW-2D-HT	tr/ <0.002	ND/< 0.00001	NA/< 0.00001		
PW-3D-LT	tr/ <0.002	tr/< 0.00001	NA/ 0.0003		
PW-3D-HT	ND/ <0.002	ND/< 0.00001	NA/< 0.00001		
PW-4D-LT	0.170/ 0.310	tr/< 0.00001	NA/ 0.0001		
PW-4D-HT	0.073/ 0.068	ND/< 0.00001	NA/< 0.00001		
PW-5D-LT	tr/ <0.002	ND/< 0.00001	NA/< 0.00001		
PW-5D-HT	tr/ 0.003	ND/< 0.00001	NA/ 0.00001		
PW-6D-LT	tr/ <0.002	tr/< 0.00001	NA/ 0.00001		
PW-6D-HT	tr/ <0.002	ND/< 0.00001	NA/< 0.00001		
PW-7D-LT	tr/ <0.002	ND/< 0.00001	NA/< 0.00001		
PW-7D-HT	tr/ <0.002	ND/< 0.00001	NA/< 0.00001		
PW-8D-LT	tr/ <0.002	ND/< 0.00001	NA/< 0.00001		
PW-8D-HT	0.012/ <0.002	tr/< 0.00001	NA/< 0.00001		
PW-9D-LT	tr/ <0.002	ND/< 0.00001	NA/< 0.00001		
PW-9D-HT	0.017/ <0.002	ND/< 0.00001	NA/< 0.00001		
PW-10D-LT	0.015/ 0.002	ND/< 0.00001	NA/< 0.00001		
PW-10D-HT	0.018/ <0.002	tr/< 0.00001	NA/< 0.00001		

tr = trace (less than 10 mg/l)
ND = None Detected (less than 1 mg/l)
NA = Not Analyzed

These concentrations are significantly lower than the concentrations detected in the first round samples. The presence of carbon tetrachloride cannot be attributed to any known on-site sources; however, it is possible that small quantities of waste solvents were periodically discharged to Taylor Lake which might account for these low, isolated concentrations. Carbon tetrachloride was not detected in any samples from the deep zone monitoring wells.

Several intermediate and deep zone monitoring wells were found to contain tetrachloroethylene. With the exception of well P-2S, which contained concentrations of 0.860 and 0.180 mg/l, all detectable concentrations of tetrachloroethylene were less than 0.0025 mg/l. Tetrachloroethane was also detected in monitoring well P-1S at levels of 1.090 and 0.270 mg/l; however, the other chlorinated ethanes were found in concentrations ranging from only 0.00001 to 0.0098 mg/l. There are no known on-site sources of tetrachloroethane or the other chlorinated ethanes.

4.8.7 Third Round Results

The third round of groundwater samples were collected from the five shallow zone monitoring wells on August 13, 1981, with analyses being performed on the limited list of parameters. The analytical results from these shallow zone samples revealed similar concentrations and distributions as detected in the intermediate zone for the various parameters with the exception of arsenic. Relatively high total chromium values ranging from 1.60 to 2.70 mg/l were detected in shallow monitoring wells P-1SS and P-3SS, whereas, the concentrations detected from previous sampling round in the intermediate zone samples were in the range of 0.005 to

1.34 mg/l with the higher concentrations being from station P-1S which is screened over both the shallow and intermediate zones. The presence of higher chromium concentrations in shallow well P-3SS is to be expected since it is located immediately downgradient of the Chlorate Pond. The presence of chromium in shallow well P-1SS reveals that either chromium is discharging from a larger area than the Chlorate Pond, or that there is a northeasterly component of flow in the surficial zone. Based upon the limited water level data available for the shallow zone, it appears that there is a northeasterly component of groundwater flow in the surficial water bearing zone which would explain these concentrations in well P-1SS.

As in the intermediate zone samples, hexavalent chromium was detected in most significant concentrations at monitoring station P-1 where values of 1.54 and 0.33 mg/l were obtained from samples PW-1SS-HT and PW-1SS-LT, respectively. The presence of total and hexavalent chromium in shallow well P-4SS was unexpected even though the concentrations were relatively low. Total and hexavalent chromium were not detected in shallow well P-10SS, and only a trace concentration (0.008 mg/l) of total chromium was detected in shallow well P-6SS.

With the exception of well P-10SS, cyanide was detected in each of the shallow zone monitoring wells with the higher concentrations being detected in wells P-6SS and P-3SS. The cyanide concentrations detected in these two shallow zone monitoring wells was somewhat higher than the concentrations detected in the intermediate zone wells at these stations during the previous sampling round. However, the highest concentration detected was only 0.124 mg/l in sample PW-3SS-LT, whereas, during the second round sampling program a cyanide concentration of 1.37 mg/l was detected in monitoring well P-9S. The concentration distribution of cyanide in the shallow zone wells does not provide any additional insight into the possibility of an on-site source of cyanide.

Chlorinated ethanes were analyzed for in samples from shallow wells P-1SS and P-3SS as a result of its detected presence in intermediate zone well P-1S. With the exception of 0.003 mg/l of tetrachloroethane, all the chlorinated ethanes were below the limit of detection in samples from shallow well P-3SS. Quantifiable concentrations of most of the chlorinated ethanes were detected in samples from well P-1SS with tetrachloroethane being detected in the most significant concentrations at levels of 0.234 to 5.630 mg/l. These concentrations of tetrachloroethane are somewhat higher than those detected in the intermediate zone well P-1S which ranged from 0.270 to 1.090 mg/l in the second round samples. These similar concentrations are to be expected in these wells due to the screened interval of well P-1S. The quality data from the shallow zone monitoring wells tend to verify the very localized distribution of the chlorinated ethanes as indicated by the previous sampling rounds. It is possible that very small quantities of solvents might have been discharged to Taylor Lake, or it might be a result of the leakage from miscellaneous drums that are located in the general area of this monitoring station, the contents of which are unknown.

As in the previous sampling rounds, a small concentration of carbon tetrachloride was detected at monitoring station P-1. A concentration of 0.106 mg/l was detected in the high tide sampling; however, none was detected in the low tide sample. A very low concentration, 0.002 mg/l, of carbon tetrachloride was also detected at station P-4SS at high tide. These very low concentrations and their isolated distribution indicate a very limited and diffuse source of this constituent. Again, it is possible that it is related to the infrequent discharge of small quantities of solvents in these areas.

Chloroform was detected in all samples collected from the shallow wells with concentrations ranging from 0.016 mg/l in well P-10SS to 3.180 mg/l in well P-1SS. These chloroform concentrations are somewhat lower than the concentrations detected in the intermediate zone wells P-1S, P-2S, and P-3S during the second round sampling program. However, somewhat higher chloroform concentrations were detected in shallow wells P-4SS and P-6SS than were detected in the intermediate zone wells P-4S and P-6S during the previous sampling rounds. The concentration distribution of chloroform in the shallow zone again reflects the relationship to the Graphite Cell Pond as well as the probable chemical reaction of free chlorine with the underlying naturally-occurring organic deposits.

With the exception of monitoring well P-4SS, arsenic was detected in all shallow zone wells at concentrations ranging from 0.33 mg/l in Well P-10SS to 3,670 mg/l in Well P-6SS. As expected, the arsenic concentrations in the shallow zone were appreciably higher than the concentrations detected in the intermediate zone from previous sampling rounds. The relatively high arsenic concentrations detected in Well P-6SS is to be expected since it is nearest the anticipated source of arsenic. The significantly lower arsenic concentrations in Wells P-3SS, P-1SS, and

P-4SS indicate that the arsenic plume is confined to a relatively small area and that considerable dilution is occurring with increased distance from the source area.

4.8.8 Fourth Round Results

Groundwater samples from the fourth sampling round were collected on September 24, 1981, from seven shallow zone monitoring wells located down gradient of the Penite area in order to more properly define and evaluate the movement of arsenic through the surficial zone and the ultimate discharge of arsenic to the waterway. The analytical results for the fourth round samples are summarized in Table 4-19. As expected, the highest arsenic concentrations were detected in samples from Well P-6SS which is located nearest the anticipated source area. Samples from wells at increased distances from the anticipated source area showed significantly lower arsenic concentrations.

Those monitoring wells located along the waterway contained concentrations of arsenic ranging from a low of 10.0 mg/l in Well P-15SS to a high of 340 mg/l in Well P-14SS. Groundwater samples from monitoring Well P-1SS contained arsenic levels of only 0.19 and 0.22 mg/l. This concentration distribution indicates that the migration of arsenic through the shallow zone is restricted to a fairly small areal distribution with considerable dilution occurring both longitudinally and transverse to the direction of groundwater flow.

4.9 SURFACE WATER

4.9.1 Area Surface Water Features

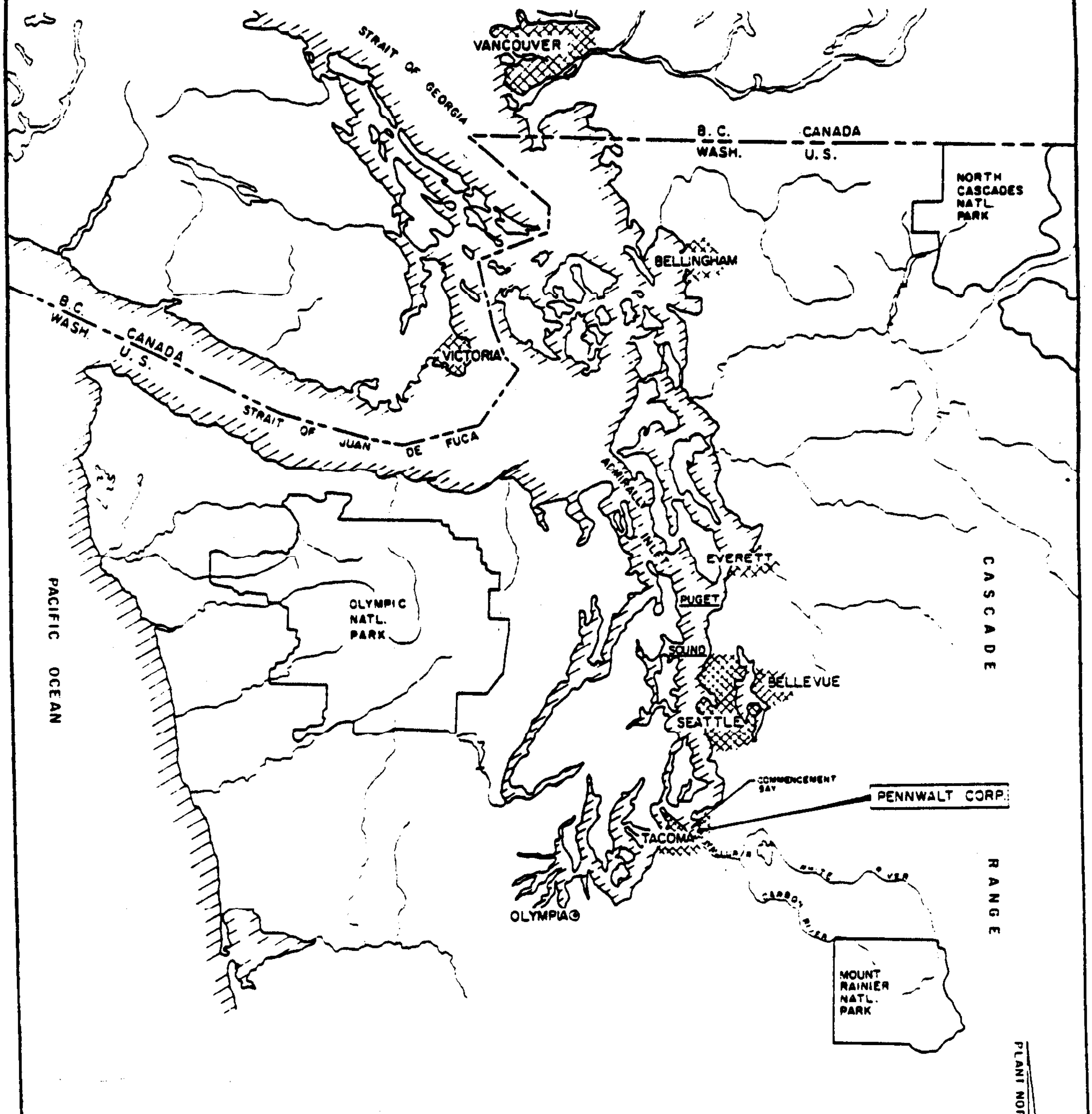
The Pennwalt site is predominantly a saltwater environment, and major surface water features for the area are shown in Figure 4-18. No fresh-water streams are located on-site, and rainfall becomes brackish with overland flow. Salt marsh grass is prevalent over the entire site.

The major surface water stream in the Commencement Bay area is the Puyallup River. The drainage area of the River includes the Carbon (south) and White (north) Rivers that originate as glaciers on Mt. Rainier (about 60 miles east from the Bay).

Hylebos Waterway is the receiving stream for NPDES discharges from Pennwalt. The Waterway is maintained to handle ship traffic, and mean lower low water (MLLW) depths in the channel are about 28 ft. The waterway is about three miles long and ranges in width from about 300 to 600 ft. Hylebos Creek (a small freshwater coastal drainage stream) enters the channel at its head and about one mile southeast from the Pennwalt site. Commencement Bay is located about two miles down channel from the Pennwalt site, and depths in the Bay quickly drop off to the 300-500 ft range. The Bay is part of Puget Sound and is located about 20 Sound miles south of Seattle and 35 Sound miles north of Olympia (Figure 4-18).

4.9.2 Tidal Information

Tidal cycles in the Bay and in Hylebos Waterway are diurnal. Typically during a 25-hr period, there is a higher tide (usually tidal height 10 to 12 ft mean lower low water or MLLW) followed by a low tide (usually



THE AWARE CORPORATION NASHVILLE, TENNESSEE HOUSTON, TEXAS

PENNWALT CORP.
Tacoma, Wash.

FIGURE 4.18

SITE LOCATION

tidal height 3 to 6 ft MLLW) followed by a high tide (usually 1 to 2 ft lower than higher high tide) and finally followed by a lower low tide (usually tidal height -1 to +1 ft MLLW). These tidal changes are usually about 5 to 7 hr apart.

This datum is about 5.7 ft lower than the geodetic mean sea level so that some confusion exists between land surface elevations based on a geodetic MSL and tidal heights based on a local MLLW. The tidal cycle for Commencement Bay for the month of April, 1981, is shown as an example in Figure 4-19 and the cycle is referenced to both MSL and MLLW.

As noted previously, all elevations in this report are reported as ft MSL based on the National Geodetic Vertical Datum and is in agreement with Pennwalt's reference BM elevation on-site.

4.9.3 Site Surface Water Features

One area stormwater runoff ditch is located along the eastern boundary of the site, and this ditch separates Pennwalt from the LA-Pacific wood yards. This ditch is tidally flooded at high tide and is basically dry except for bank seepage during low-tide periods. Petroleum Reclaiming located at the southeast corner of Pennwalt's property has an intermittent discharge (pipe) into the head of the ditch, and Pennwalt diverts stormwater runoff from the Taylor Lake area into the ditch.

Several seeps and storm or effluent sewers discharge into the Hylebos Waterway at the Pennwalt site (Plate 1). Flows from these seepage/discharge points were monitored on several occasions and the flow data presented in Table 4-28. The average seepage flow measured was about 0.004 cfs or about 2,520 gal/day.

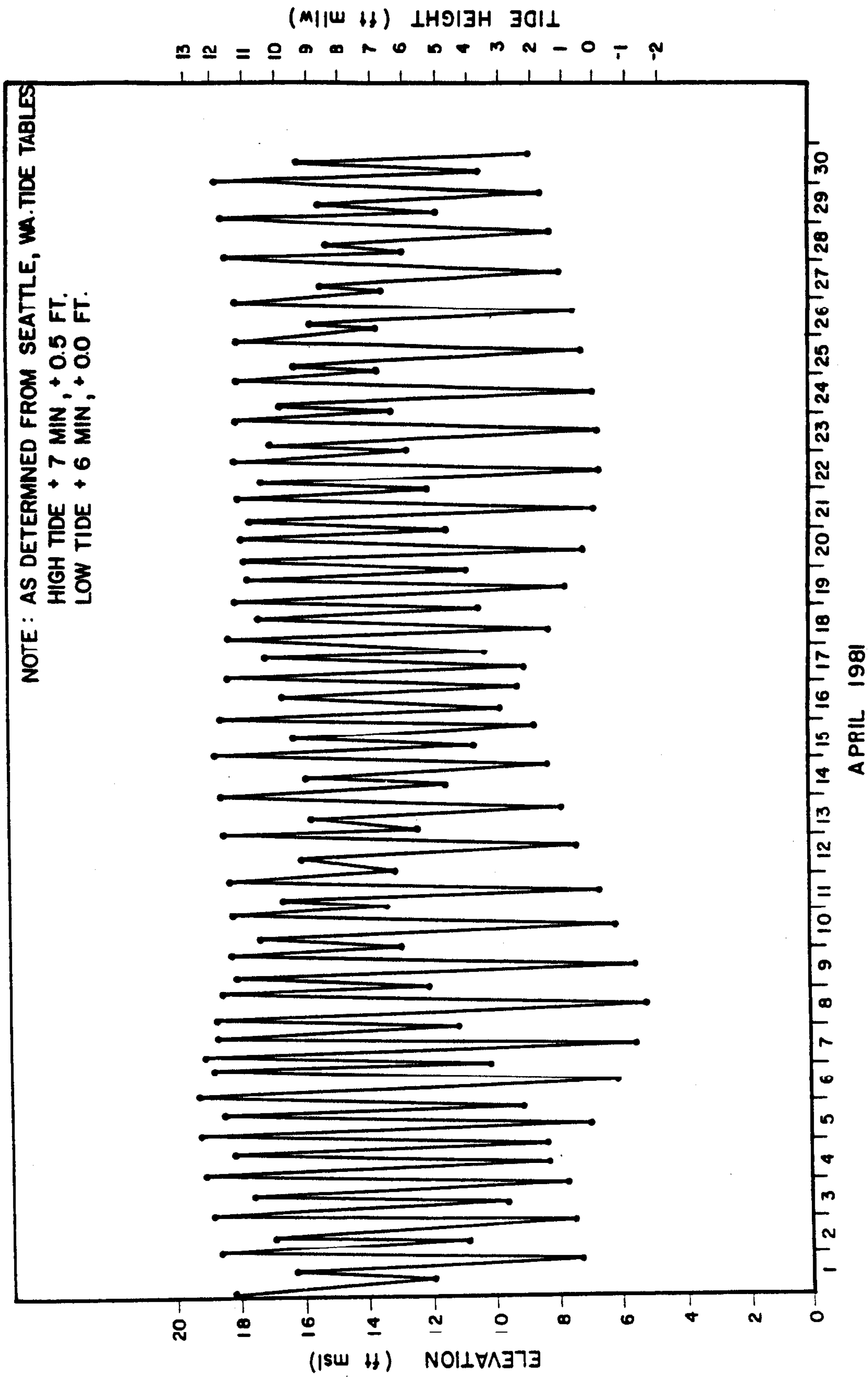


FIGURE 4.19 TIDAL CYCLE FOR COMMENCEMENT BAY

TABLE 4-28

SURFACE WATER ANALYSES
PENNWALT, TACOMA

Parameter/Sample No.	E. Drainage NW1	NW1 AR	NW2	NW2 AR	Seeps NW3	NW4	NW5	NW7	Sewers NWI	NW8	NW8 AR	NW10	NW11
		After Rain											
pH	11.7	--	11.25	11.05	7.60	8.95	9.05	12.0	7.3	9.1	3.2	10.9	10.5
Chlorine (mg/l)													
Free	25	--	0.7	0.7	20	360	280	140	< 0.1	< 0.1	--	< 0.1	< 0.1
Total Residual	25	--	0.7	0.7	20	380	280	180	1.2	< 0.1	--	< 0.1	< 0.1
Salts (mg/l)													
Conductivity (micromhos)	32,000	--	18,000	14,000	13,000	12,000	12,000	46,000	800	750	2,200	2,850	6,000
Cl	13,000	5,900	7,400	4,900	5,400	4,800	4,700	**	420	280	320	770	2,100
Na	9,500	4,400	10,000	4,800	4,300	4,000	3,300		280	130	190	620	1,400
Mg	28	31	30	35	60	56	31		8.1	3.6	6.7	1.2	8.5
Ca	70	60	70	80	230	130	90		19	9.6	12	60	10
Metals (mg/l)													
Cu (T)	0.010	0.036	0.018	0.030	0.16	< 0.002	< 0.002	**	0.017	0.006	0.026	0.028	0.015
Ni (T)	< 0.005	0.13	0.005	0.060	0.010	< 0.005	< 0.005		0.84	< 0.005	0.023	0.005	0.017
Zn (T)	< 0.002	0.052	0.005	0.087	0.49	< 0.002	0.007		0.029	< 0.002	1.2	0.060	0.025
Sb (T)	< 0.01	0.01	< 0.01	0.02	0.04	< 0.01	< 0.01		0.01	0.02	0.01	1.1	0.08
Cr (T)	0.47	0.12	0.29	0.11	0.21	0.49	0.40		0.011	0.015	0.015	0.037	0.037
EP Toxicity (mg/l)													
As (T)	0.77	1.7	1.1	1.4	0.17	0.31	0.04	**	1.2	2.0	1.2	75.	49.0
Ba (T)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Cd (T)	< 0.002	< 0.002	< 0.002	< 0.002	0.006	< 0.002	< 0.002		< 0.002	< 0.002	0.002	< 0.002	< 0.002
Cr (T)	0.10	0.06	0.08	< 0.01	0.15	< 0.01	< 0.01		< 0.01	< 0.01	0.05	< 0.01	< 0.01
Pb (T)	< 0.005	0.005	0.007	0.005	< 0.005	< 0.005	< 0.005		< 0.005	< 0.005	0.020	0.013	< 0.005
Hg (T)	0.005	0.005	0.005	0.011	0.004	0.004	0.002		0.006	0.002	0.011	0.007	0.016
Se (T)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01		< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ag (T)	< 0.002	< 0.002	< 0.002	< 0.002	0.010	0.003	< 0.002		< 0.002	< 0.002	< 0.002	0.013	< 0.002
Trihalomethanes (mg/l)													
Chloroform	10.200	1.800	*	0.710	**	12.200	34.000	5.200	0.130	0.150	*	*	*
Dichlorobromomethane	0.018	< 0.010		< 0.010		0.280	0.400	0.030	ND	0.012			
Dibromochloromethane	< 0.010	< 0.010		ND		0.050	0.090	0.080	ND	0.001			
Bromoform	< 0.001	< 0.010		ND		< 0.001	< 0.001	0.130	ND	0.001			
Carbon Tetrachloride	< 0.001	< 0.001		ND		< 0.001	< 0.001	ND	ND	0.001			
Flow (gpm)	3.2	--	7.0	--	0.25	0.25	0.25	1.0	--	3.0	--	3.0	4.0

**Lost by lab (unable to collect subsequent sample from November 3 since discharge from seep was stopped)
*Sample lost due to lab accident.
ND - None Detected
(T) - Total Analysis
Note: Samples collected April 7, 1981 except for after rain samples.

Where are the EP toxicity 4B } why

UNITS

ELF000306

4.9.4 Site Discharges to the Hylebos Waterway

Pennwalt discharges (at their main effluent diffuser located beneath their dock) about 11.86 MGD of process wastewaters to the Waterway. A schematic of the process wastewater flows to this discharge point is presented in Figure 4-20. Several minor sewer flows also enter the Waterway, and average flows for these are presented in Table 4-28. A schematic location map of these sewer lines is provided in Figure 4-21. Total effluent discharges to the Waterway including seepage are about 11.94 MGD. Seepage accounts for about 1 MG/month or an estimated 39,000 gal/day (0.06 cfs). An estimated water balance for the site is presented in Figure 4-22. Sewer flows account for over 99.6 percent of the effluent flow of 11.94 MGD reaching the Hylebos Waterway. For comparative purposes, one tidal exchange in Hylebos Waterway (high to low tide of 10 ft height change) represents about 474 MG of water (about 2,900 cfs over 6 hrs) and at MLLW of 0.0 ft about 1,300 MG are contained in the Waterway.

4.9.5 Surface Water Quality

Several seeps, open ditches, and sewer outfalls were sampled during the initial field surveys during April 1981. Sampling locations have been previously shown in Figure 3-2. In situ measurements for water temperature, pH and conductivity were made at each location. Water samples were collected for futher laboratory chemical characterization. All field and laboratory data results for these initial samples are presented in Table 4-28. The East Drainage Ditch, 2 seeps and the East Sewer were selected for priority pollutant analyses and these results are given in

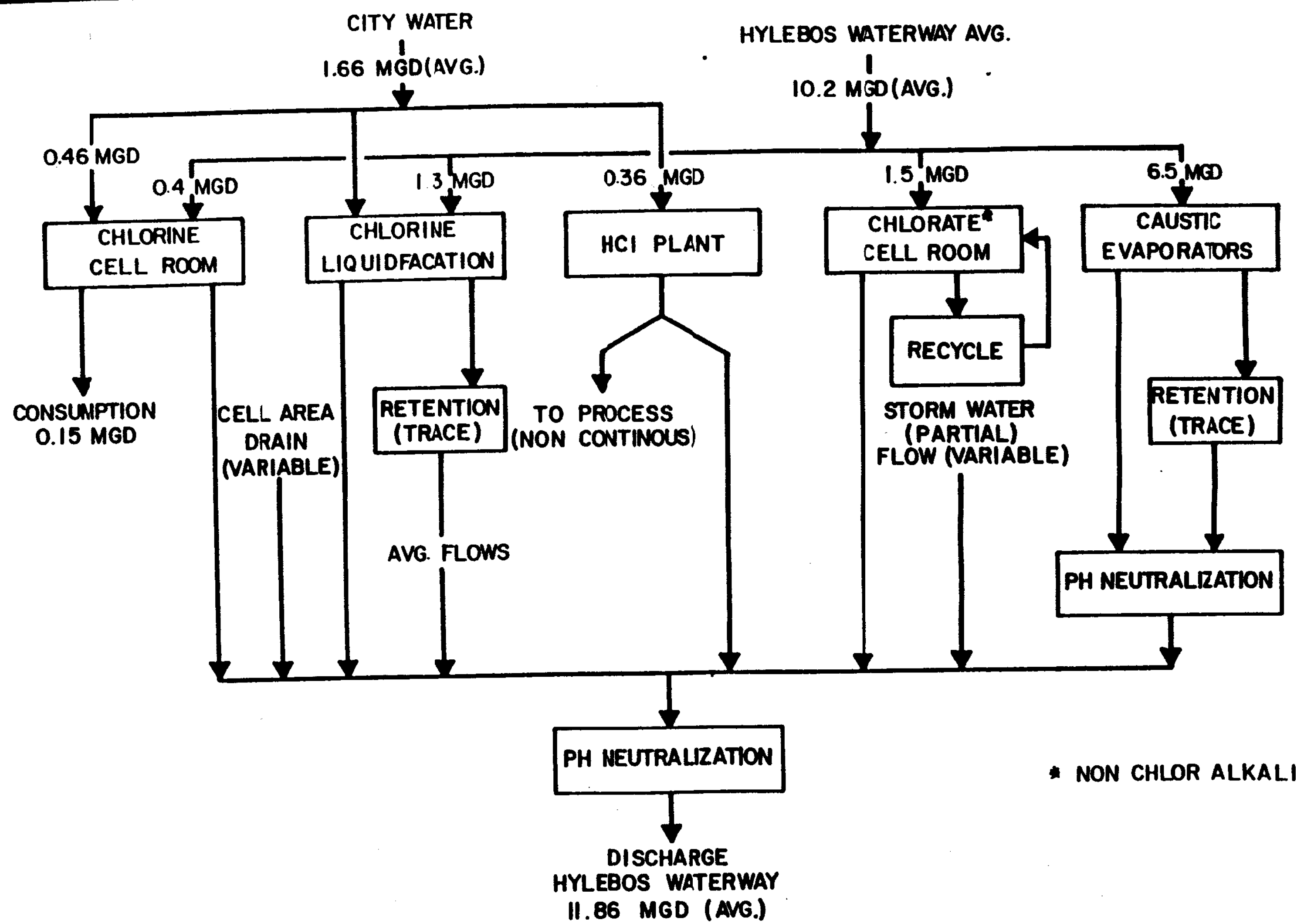
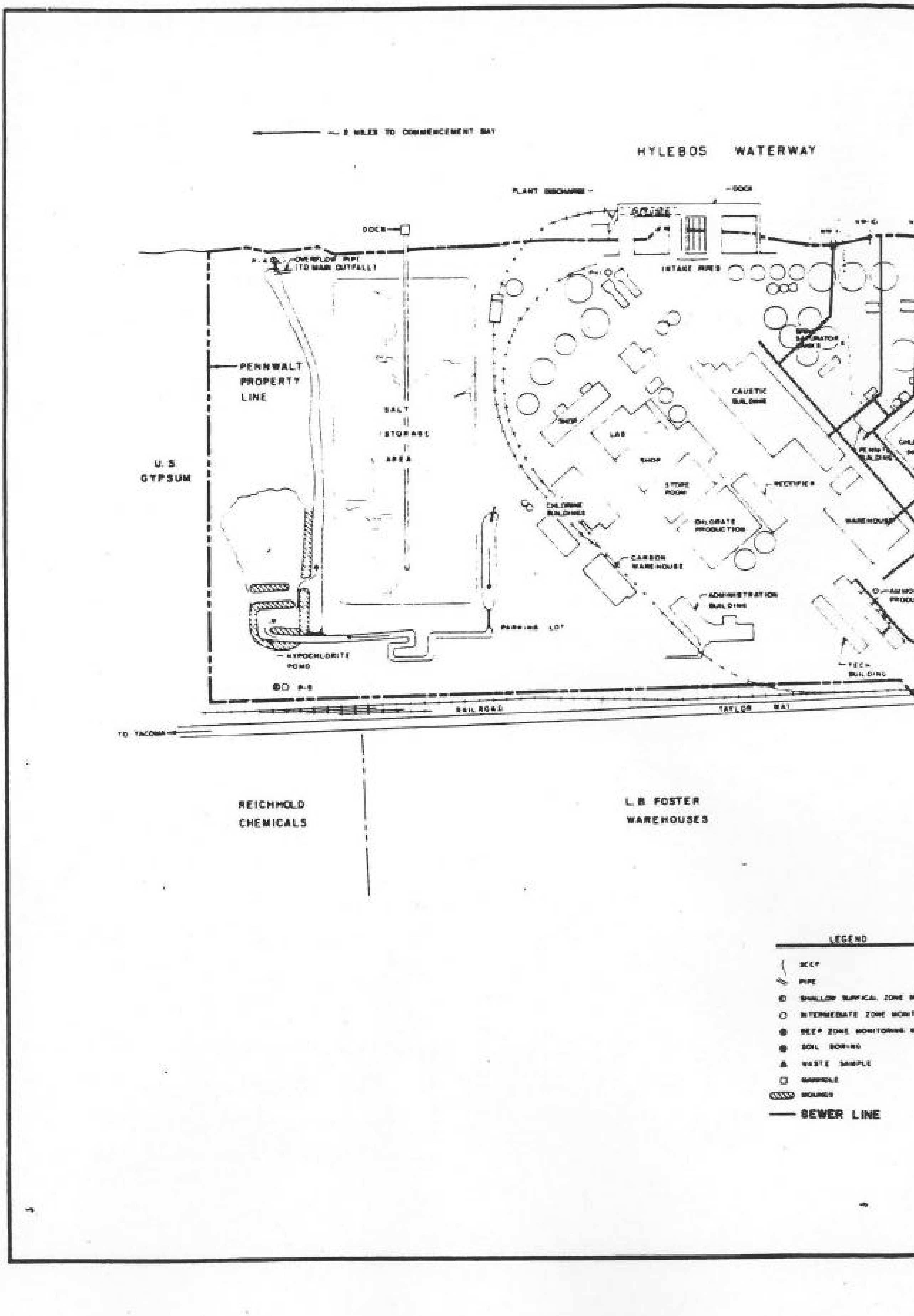
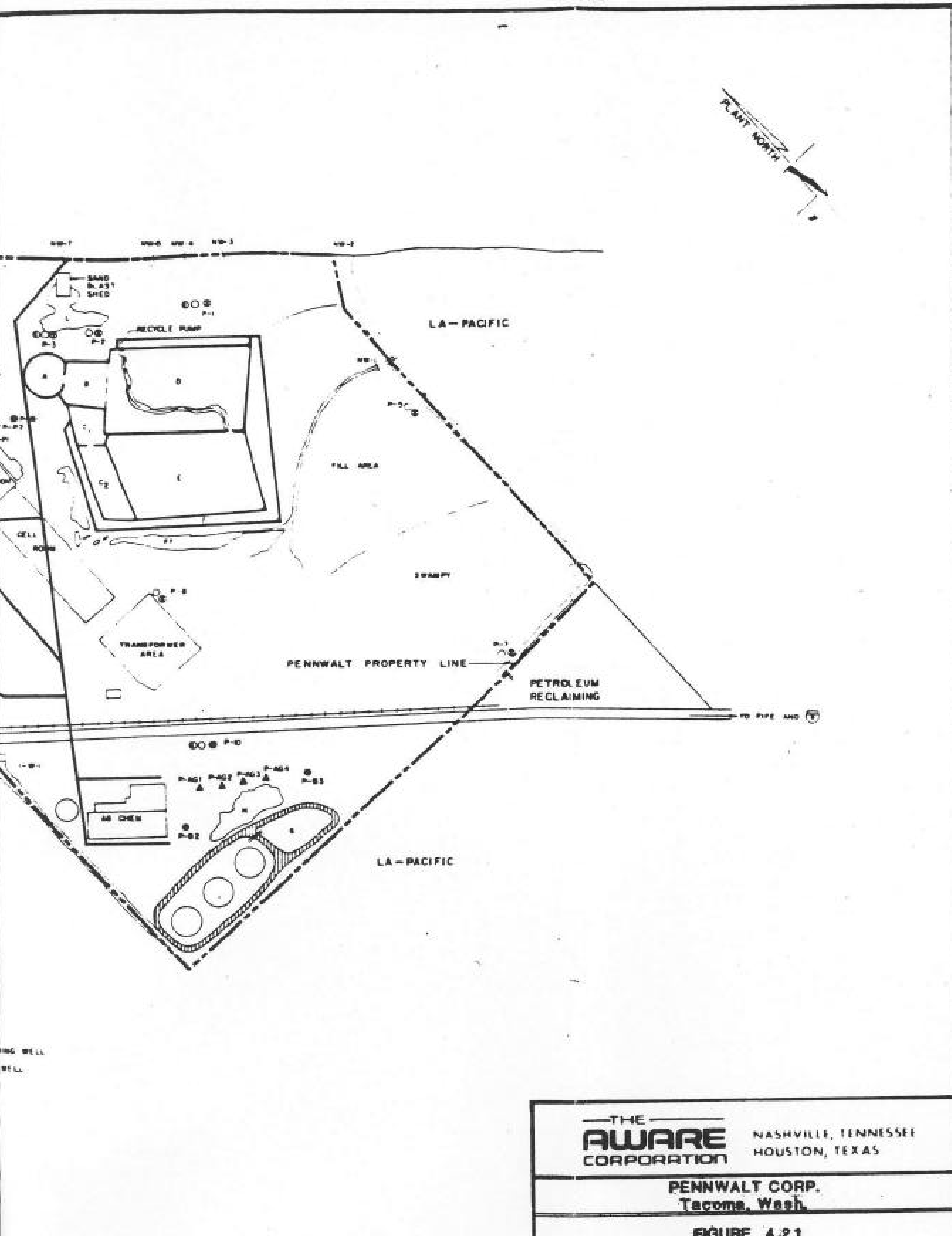


FIGURE 4.20 SCHEMATIC OF WATER FLOW



2 MILES TO COMMENCEMENT BAY
HYLEBOS WATERWAY
PLANT DISCHARGE
DOCK
DOCK
OVERFLOW PIPE (TO MAIN OUTFALL)
INTAKE PIPES
PENNWALT PROPERTY LINE
U. S. GYPSUM
SALT STORAGE AREA
CAUSTIC BUILDING
SHOP
LAB
SHOP
STORE ROOM
RECTIFIER
CHLORINE BUILDINGS
CHLORATE PRODUCTION
CARBON WAREHOUSE
WAREHOUSE
ADMINISTRATION BUILDING
PARKING LOT
HYPOCHLORITE POND
TECH BUILDING
RAILROAD
TAYLOR WAY
TO TACOMA
REICHHOLD CHEMICALS
L.B. FOSTER WAREHOUSES
LEGEND
SEEP
PIPE
SOIL BORING
WASTE SAMPLE
MANHOLE
MOUNDS
SEWER LINE



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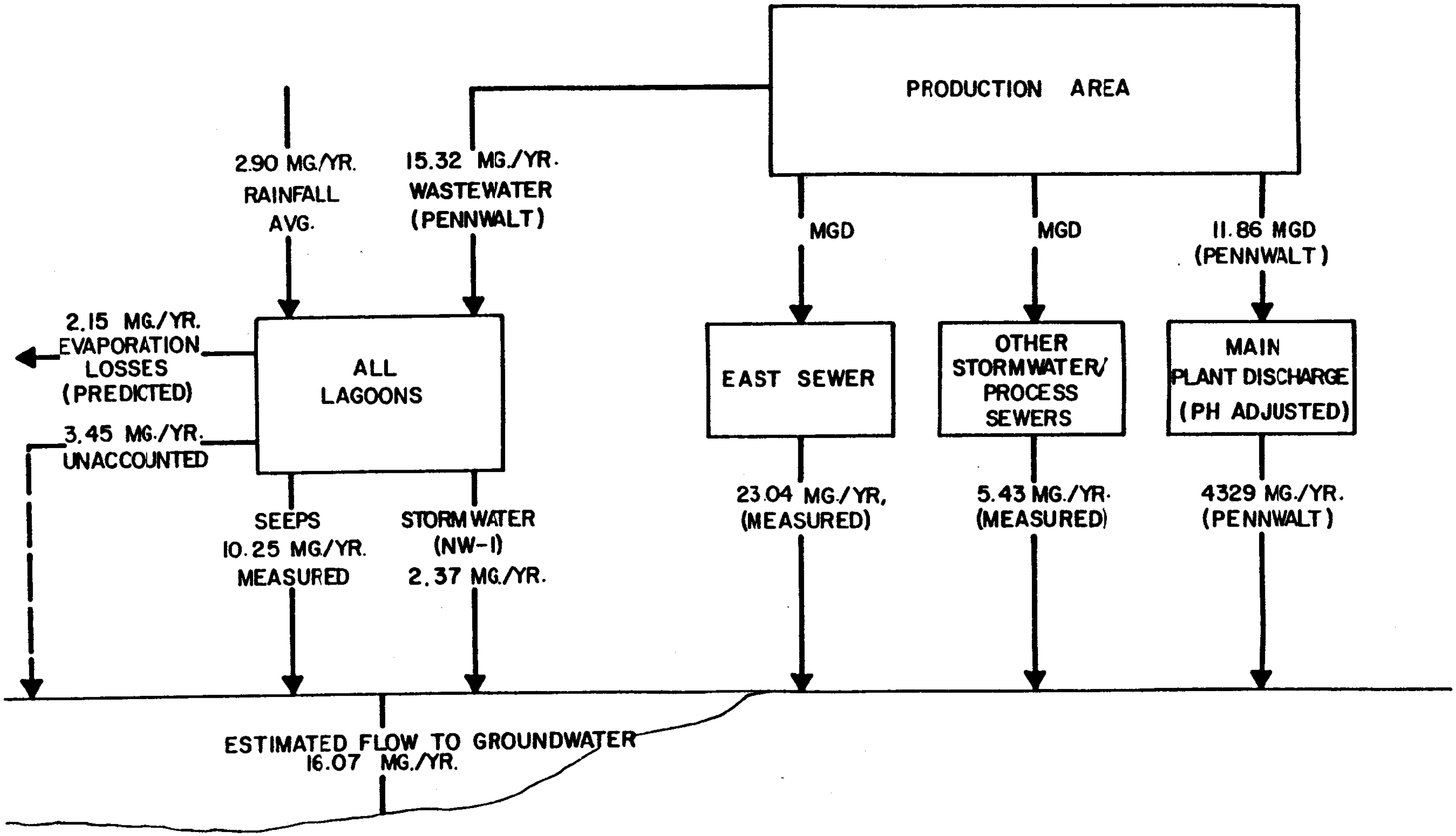
Tacoma, Wash.

FIGURE 4.21

SEWER LINE LOCATION MAP



HYLEBOS WATERWAY ESTIMATED AVERAGE TOTAL
FLOW RECEIVED FROM PENNWALT = 4374 MG/YR
OF WHICH 99.6 % IS SEWER EFFLUENT FLOW

FIGURE 4.22 SCHEMATIC OF PENNWALT EFFLUENT FLOW TO HYLEBOS WATERWAY

Table 4-28. Additional samples were collected from seep NW7 and sewer NW10 during the third sampling round with analyses being performed for halomethanes, chlorinated ethanes, and selected metals. The results for these two subsequent samples are presented in Table 4-29.

The data results from the surface water sampling program found that chloroform and arsenic were the only two parameters in significantly high concentrations. High arsenic concentrations ranging from about 25 to 75 mg/l were found in seep NW7 (behind the sandblasting shed) and sewers NW10 and NW11 (to the west of old Penite disposal areas). Seep NW 7 is thought to be in the vicinity of an old plugged sewer line that runs underneath the Taylor Lake disposal area. This old sewer line is probably acting as a contaminant transport pathway from the old Penite sludge pond area. The arsenic in the two sewer lines probably originated at the old Penite operations and leachate potentially infiltrating into these old sewer lines.

Elevated chloroform concentrations are resultant from the old graphite cell pond area (anode disposal) and to a lesser extent from wastewater containing free chlorine that was discharged to the Cell Room Pond. A drop in chloroform concentrations (5.2 to 0.35 mg/l) in waters from Seep NW 7 was observed when discharges to the Cell Room Pond were discontinued during the summer.

4.9.6 Flood Potential

The Pennwalt site is not in a freshwater 100-yr floodplain. It is not considered a high hazard area due to coastal flooding. The site was partially flooded in the 1920's during initial construction activities and

TABLE 4-29

ANALYTICAL RESULTS FROM SURFACE WATER SOURCES
ON AUGUST 13, 1981

Parameter	Surface Water Source	
	N-W-7	N-W-10
pH	11.7	11.2
Arsenic	25.3	114.
Hexavalent chromium	5.6	<0.005
Total chromium	5.7	<0.005
Total cyanide	0.079	0.015
Chloroform	0.350	0.018
Carbon tetrachloride	<0.00001	<0.00001
1,1, Dichloroethane	<0.00001	<0.00001
1,2 Dichloroethane	<0.00001	<0.00001
1,1,1 Trichloroethane	<0.00001	<0.00001
1,1,2 Trichloroethane	<0.00001	<0.00001
Tetrachloroethane	0.143	0.052
1,1,2,2 Tetrachloroethane	<0.00001	0.001

prior to chemical production. A flood hazard map for the site and Hylebos Waterway is presented in Figure 4-23.

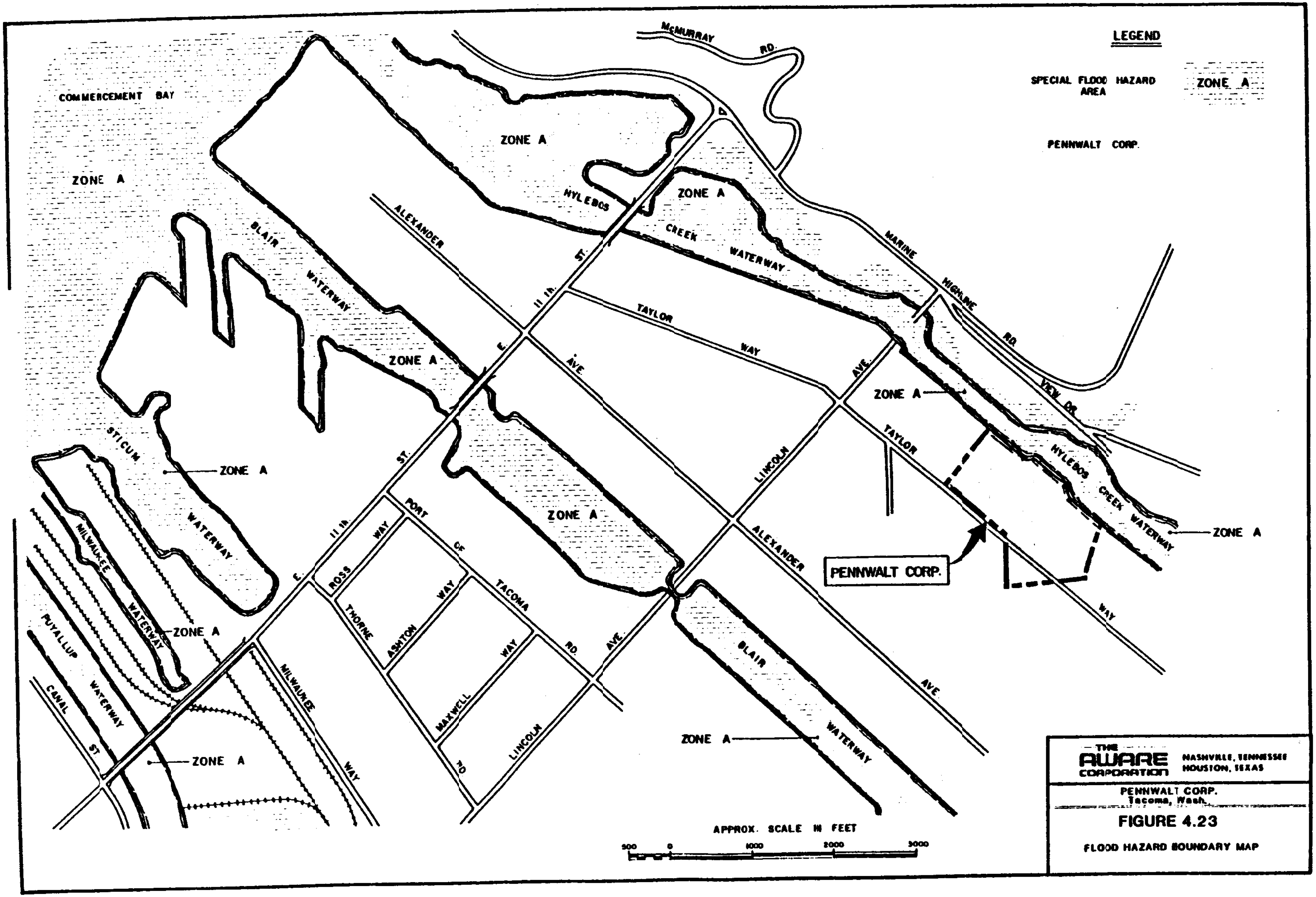


FIGURE 4.23
FLOOD HAZARD BOUNDARY MAP

SECTION 5

CONTAMINANT LOADING EVALUATION

5.1 INTRODUCTION

It was determined from this study that there are four separate pathways at the Pennwalt facility controlling the transport of contaminants and their ultimate discharge to the Hylebos Waterway. These four pathways include:

1. Groundwater
2. Visual seeps along the waterway
3. Three sewer lines
4. Surface runoff

Of the pathways listed above, the groundwater and visual seeps are essentially the same since the visual seeps along the waterway are the result of groundwater discharge in localized zones. In addition, it was determined during the course of this investigation that the identifiable seepage zones along the waterway were directly related to the operation of the lagoons in the Taylor Lake area.

5.2 GROUNDWATER LOADING

5.2.1 Introduction

In evaluating the loading of contaminants to the groundwater and their subsequent transport and discharge to surface receiving streams, there are several physical and chemical factors that influence the migration of contaminants which should be considered. Some of the more important factors that should be evaluated include:

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1. Location and areal extent of contaminant source.
2. Physical and chemical characteristics of contaminant source.
3. Hydrogeologic setting including determination of boundary conditions.
4. Location of groundwater recharge and discharge areas.
5. Direction of groundwater flow (prevailing hydraulic gradient).
6. Permeability and effective porosity.
7. Rate of groundwater flow.
8. Quantity of groundwater discharge.
9. Ambient groundwater quality.
10. Contaminant concentration in groundwater.

The above factors were considered during the development and implementation of this investigation in order to allow a reasonable approximation of contaminant migration through the groundwater system and subsequent loading rates to the waterway from the groundwater system. Information pertaining to the above factors has been presented in the preceding sections of this report.

5.2.2 Site Specific Groundwater Quality Conditions

Based upon the results of the investigative and monitoring programs undertaken as part of this investigation and discussed in Section 4, it is readily apparent that contaminant migration at the Pennwalt facility is occurring primarily through the shallow surficial zone. The test borings and monitoring wells installed at the site revealed the presence of three separate water-bearing units which are separated by continuous silt and clay layers. These three zones were found to be basically separate flow systems with only minimal vertical leakage between zones. Groundwater flow and ultimate discharge from each of these zones was determined to be to the Hylebos Waterway.

The analytical results from the groundwater monitoring program show that the vast majority of contaminants are contained within the upper, shallow surficial zone with arsenic being the contaminant of most concern and chloroform being of secondary significance. Chromium is also of some limited concern, however, it and the remaining parameters investigated during this program were very localized in distribution and were detected in very low concentrations compared to background quality resulting in minimal impact. Minor amounts of arsenic and chloroform have evidently moved vertically into the underlying intermediate water-bearing zone, however, this is apparently restricted to a very small area in the vicinity of monitoring stations P-1, P-2, P-3, and P-6. The contaminants detected at stations P-1, P-2, and P-3 are possibly the result of thinning of the upper confining layer between these two zones in this area or the hydraulic connection created between the shallow and intermediate zone by monitoring well P-1S. With the exception of low arsenic concentrations at station P-6D, it appears that the contaminants of concern have not migrated vertically into the deep water-bearing zone. The presence of low arsenic concentrations in well P-6D, as well as the presence of low contaminant concentrations in the intermediate zone wells, might also be attributable to vertical seepage around the well seals.

Based upon the concentrations of arsenic, chloroform, and chromium detected in the samples from the surficial water-bearing zone, the areal distributions of these constituents were delineated (Figures 5-1, 5-2, and 5-3). The boundaries of these contaminant plumes are approximate; however, they are believed to be close approximations based upon both quality data and physical data.

5.2.3 Groundwater Loading

Although the vast majority of contaminant migration in the groundwater was found to be through the upper surficial zone, this zone represents a man-made, water-bearing zone of limited areal extent and definable boundaries. It is not considered to be a naturally-occurring groundwater aquifer. Based upon the results from the groundwater monitoring program at the facility, this surficial zone has apparently contained the contaminants of concern within a relatively small area and has prevented any significant vertical migration of contaminants into the intermediate and deep zones which represent naturally-occurring groundwater aquifers. Therefore, the naturally-occurring groundwater system has been protected to a significant extent by the presence of the overlying surficial zone and the intervening confining layers of silt and clay.

As a result of the prevailing hydrogeologic conditions in this surficial water-bearing zone, the movement of arsenic and other contaminants within this zone are expected to be confined to an area totally within the Pennwalt plant property. The observed groundwater gradients and the results of the sampling program show that contaminants would migrate essentially to the north towards the waterway. In addition, it is not expected that there would be any on-site or off-site groundwater withdrawals from this zone that might alter the current movement of contaminants through the zone.

Of primary concern in this investigation was the determination of the rate of contaminant loading to the Hylebos Waterway as a result of groundwater seepage. Based upon the preceeding discussions, it is obvious that the primary pathway for contaminant migration through the groundwater is the shallow surficial zone. In order to estimate the approximate contaminant loading to the waterway, certain basic assumptions need to be made as a result of the complex variables involved. First specific boundary conditions must be established to delineate both the areal and vertical limits of the contaminant plume. The areal distributions for arsenic, chloroform, and chromium have been previously identified in Figures 5-1, 5-2, and 5-3, with the vertical limits being the total saturated thickness of the given water-bearing zone. An average aquifer permeability and hydraulic gradient must then be assumed to be representative of the entire water-bearing zone. Finally, a contaminant concentration representative of the discharging groundwater must be established.

In order to quantify the amounts of contaminants being discharged to the waterway via the underlying groundwater system, the following equation can be utilized:

$$Q_c = \frac{KIAC \times 8.337}{1,000,000}$$

where:

Q_c = quantity of constituent discharged (lb/day)

K = permeability of water-bearing zone (gpd/sq ft)

I	=	hydraulic gradient (ft/ft)
A	=	cross-sectional area perpendicular to flow (sq ft)
C	=	concentration of given constituent (mg/l)
8.337	=	conversion factor from gal to lb of water

The above equation was utilized to determine the approximate quantities of arsenic, chloroform, and chromium being discharged to the Hylebos Waterway from the shallow water-bearing zone, and chloroform and arsenic from the intermediate water-bearing zone. The results of the calculations for chloroform and chromium in the shallow zone and chloroform and arsenic in the intermediate zone are summarized in Table 5-1. The minimum and maximum values provided are based upon the minimum and maximum measured or estimated permeabilities of each zone. The average chloroform concentration in the shallow zone was based upon two measurements from each of wells P-1SS and P-3SS, whereas, the average chloroform concentration in the intermediate zone was based upon four measurements from each of wells P-1S, P-2S, and P-3S. The average arsenic concentration in the intermediate zone was based on measurements from well P-6S.

In order to calculate the amount of arsenic discharging from the surficial zone, a more detailed evaluation was conducted. The three shallow zone monitoring wells located closest to the Hylebos Waterway, wells P-12SS, P-14SS, and P-15SS, were utilized since these wells are located downgradient of the Penite site and the arsenic concentrations in these wells should be most representative of the quality of groundwater discharging to the waterway. Monitoring well P-1SS was also utilized in the evaluation since quantifiable concentrations of arsenic were detected

TABLE 5-1

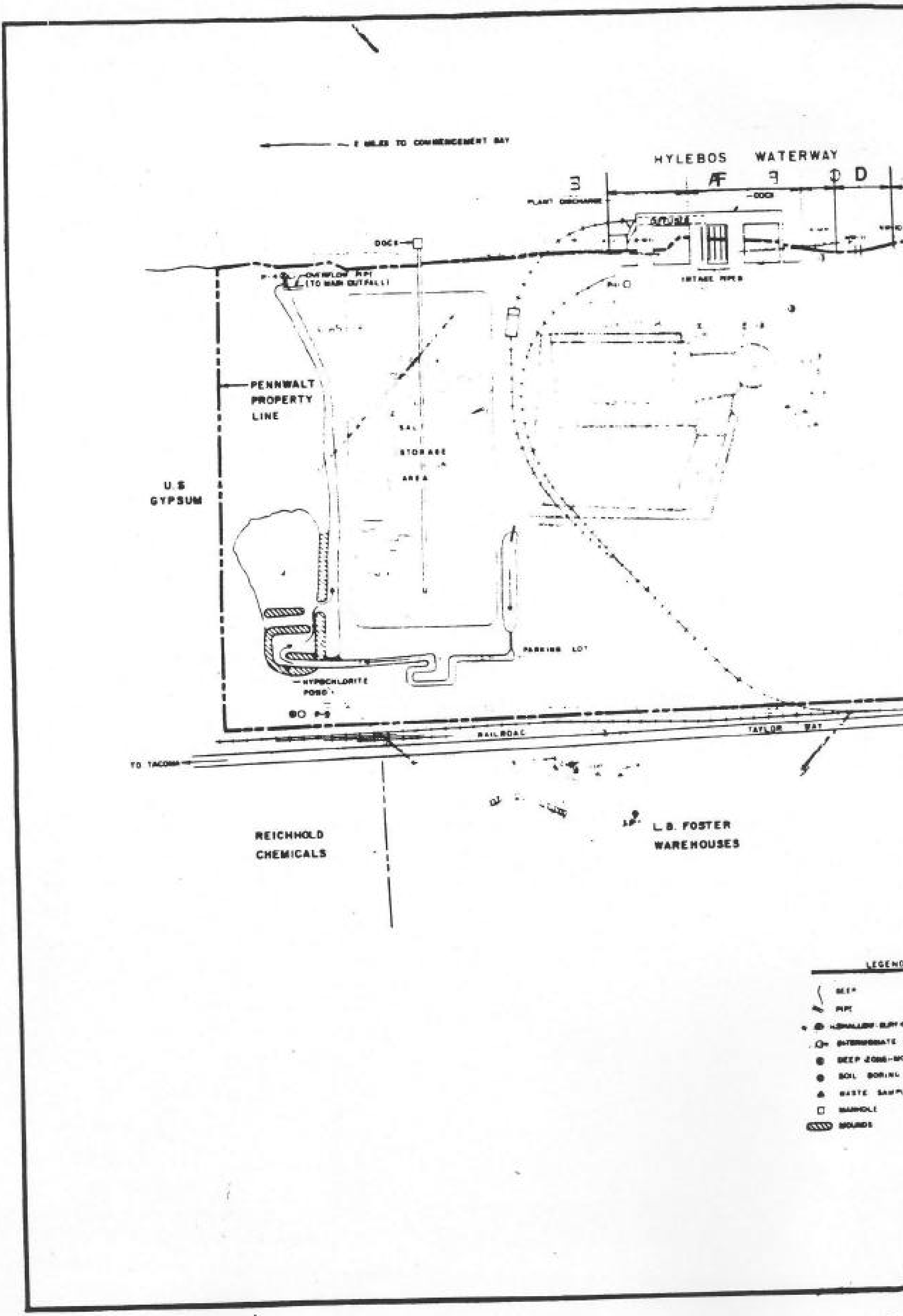
ESTIMATED LOADING RATES TO HYLEBOS WATERWAY FOR 24 HOUR PERIOD

Parameter	Average Groundwater Concentration (mg/l)	Plume Width (ft)	Groundwater Discharge Rate (gpd) Min/Max	Loading Rate to Waterway (lb/day) Min/Max
Shallow Zone:				
Chloroform	2.2	355	780-1,010	0.014-0.018
Chromium	1.97	400	880-1,140	0.014-0.019
Intermediate Zone:				
Chloroform	4.09	540	2,480-6,590	0.085- 0.22
Arsenic	0.26	300	1,377-3,672	0.003-0.008

in the well. This well was established as the eastern-most extent of the arsenic plume since the concentrations detected in the well are at such low levels that any subsequent loading to the waterway would be extremely low.

In calculating the discharge of arsenic to the waterway from the shallow zone, the arsenic plume was subdivided into six separate discharge zones. These zones are depicted in Figure 5-4 and were delineated based upon detected arsenic concentrations in the shallow zone monitoring wells. In order to more accurately calculate the total arsenic loading to the waterway, an arsenic concentration distribution curve was developed for the shallow zone along the Hylebos Waterway (Figure 5-5). From this concentration distribution curve, arsenic concentrations for discharge zones D and F were projected. Based upon the observed and projected arsenic concentrations in the six discharge zones, a total of 0.92 to 1.03 lb/day of arsenic were calculated to be discharging to the waterway (Table 5-2).

It is apparent from the preceding loading calculations that only very low quantities of contaminants are being discharged to the Hylebos Waterway from the groundwater system. The maximum calculated loading rates for chloroform and chromium of 0.24 and 0.019 lb/day, respectively are considered to be very low. The total loading of approximately 1 lb/day of arsenic to the waterway is also considered to be low. Due to the length of time since the arsenic wastes were disposed, it is believed that the groundwater system should have reached steady-state flow conditions with the contaminant concentrations decreasing with time. Therefore, the discharge of arsenic to the waterway should continue to decrease with time except for minor seasonal fluctuations.



HYLEBOS WATERWAY
PLANT DISCHARGE
DOCK
INTAKE PIPES
OVERFLOW PIPE (TO MAIN OUTFALL)
PENNWALT PROPERTY LINE
U.S GYPSUM
SALT STORAGE AREA
PARKING LOT
HYPOCHLORITE POND
RAILROAD
TAYLOR WAY
TO TACOMA
REICHHOLD CHEMICALS
L.B. FOSTER WAREHOUSES

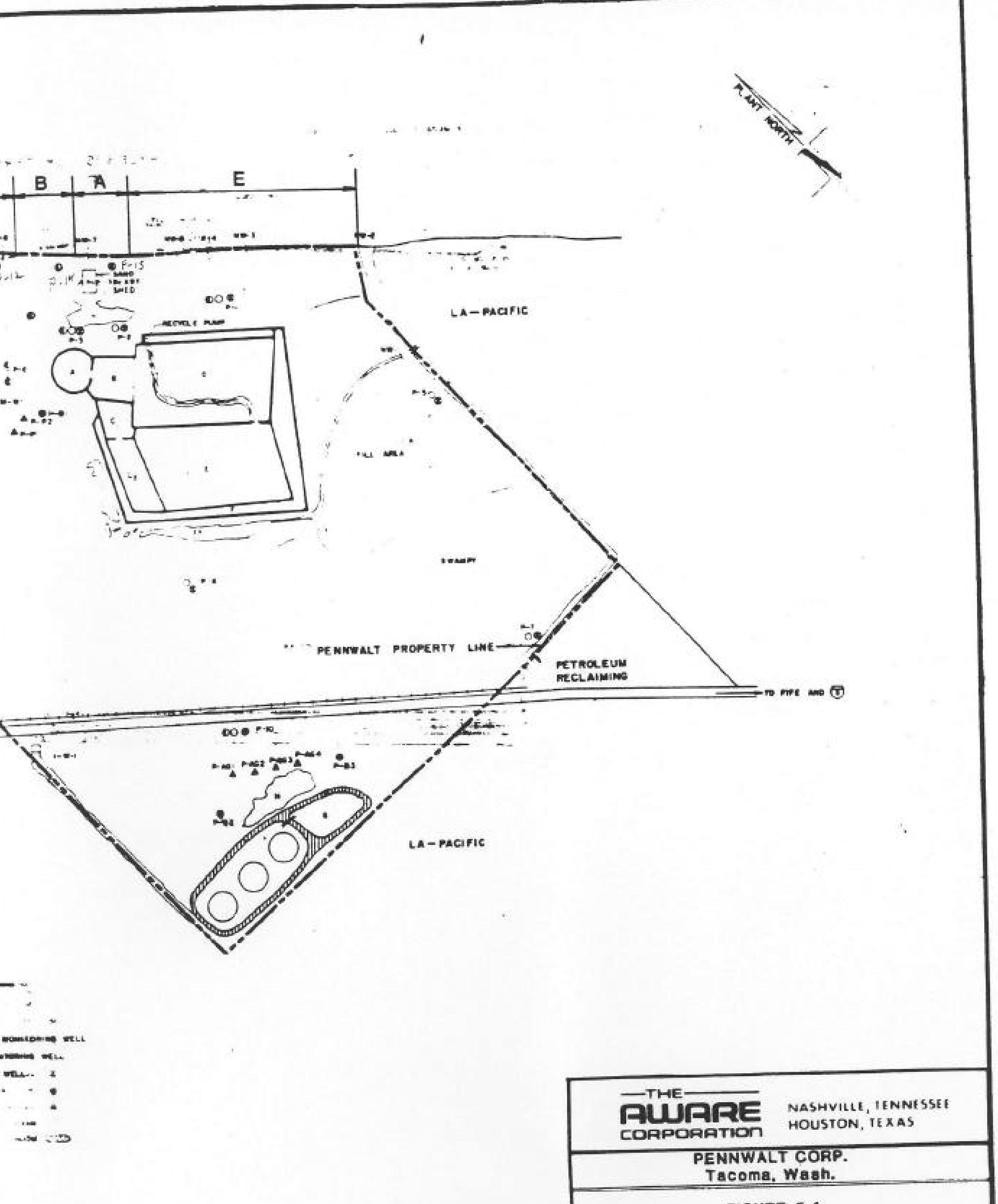


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FIGURE 5.4

DISCHARGE ZONES UTILIZED IN CALCULATING ARSENIC LOADING TO HYLEBOS WATERWAY

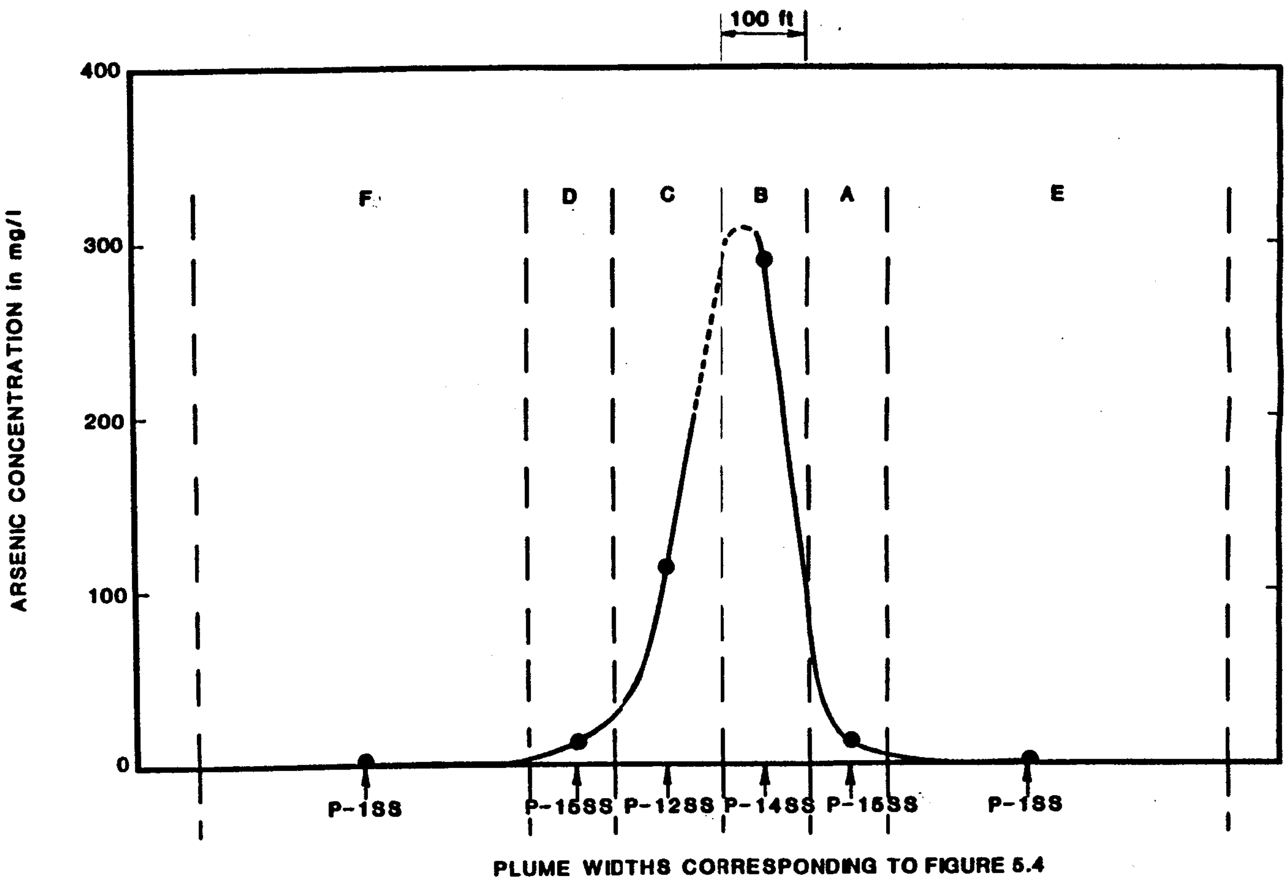

FIGURE 5.5 APPROXIMATE ARSENIC CONCENTRATION DISTRIBUTION TRANSVERSE TO GROUNDWATER FLOW IN THE SHALLOW ZONE ALONG HYLEBOS WATERWAY

TABLE 5-2

ESTIMATED ARSENIC LOADING RATES TO HYLEBOS WATERWAY FROM THE SHALLOW ZONE FOR 24-HOUR PERIOD

Zone[a]/ Monitoring Well	Average Groundwater Concentration (mg/l)	Plume Width (ft)	Groundwater Discharge Rate (gpd)(max/avg)	Loading Rate to Waterway (lb/day) Max/Avg
A/P-15SS	10.8	90	256/ 227	0.02/0.02
B/P-14SS	287.5	95	270/ 239	0.65/0.58
C/P-12SS	111.5	125	355/ 315	0.33/0.29
D/[b]	10.8	100	284/ 252	0.03/0.03
E/P-1SS	0.2	390	1,108/ 983	0.002/0.002
F/[c]	0.2	390	1,108/ 983	0.002/0.002
Total	--	1,190	3,381/2,999	1.03/0.92

[a]From Figure 5-5.

[b]Assuming a uniform concentration distribution across discharge front, assumed to be same concentration as A.

[c]Assumed to be same concentration as E.

Permeability = [illegible]

I = [illegible]

A = Saturated [illegible]

To: KI AC [illegible]

5.3 VISUAL SEEPS

A total of four identifiable seepage zones were located and sampled during this investigation. As previously discussed in Section 4, these four seepage zones were located just north of the Taylor Lake area along the Hylebos Waterway, and were designated as stations NW-3, NW-4, NW-5, and NW-7 (Plate 1). The seepage zones represent discharge from the shallow water-bearing zone, and were apparently controlled to a significant degree by the ponds in the Taylor Lake area. Upon the discontinuation of discharge to the Cell Room Pond, the discharge from the seepage zones was reduced to the extent that they were not readily identifiable from visual observations.

A single sample was collected from each of the four seepage zones during the initial field surveys in April 1981 with subsequent samples being collected from station NW-7 during the third round of groundwater sampling. The analytical results of these samples have been previously presented in Tables 4-28 and 4-29 of Section 4. Based upon the analytical results for the seepage zone samples, chloroform, chromium, and arsenic were found to be the most significant constituents in the seep discharges. Utilizing the analytical results from the initial samples and the measured flow rates at these seeps, the loadings in lb/day from the seeps would be as follows:

Seep	Chloroform	Chromium	Arsenic
NW-3	*	0.0005	0.0005
NW-4	0.04	0.001	0.0009
NW-5	0.10	0.001	0.0001
NW-7	0.06	*	*

*Analysis not performed (samples lost in Lab).

It is readily apparent from the above calculations that only very minor amounts of contaminants were being discharged from the seeps at the time these samples were collected. Subsequent to these samples, the discharge to the Cell Room Pond was discontinued, which resulted in a significant decrease in discharge from the seeps. With the exception of seep NW-7, there was no observable flow from these seepage zones during subsequent sampling rounds. During the third sampling round, a sample was collected from seep NW-7; however, the flow was too low to measure. If it is estimated that the flow was as high as 0.25 gal/min, then based upon the detected level of chloroform in the sample from NW-7, the discharge of chloroform would be approximately 0.001 lb/day. Therefore, only very minimal quantities of contaminants would be expected to be currently discharging to the waterway from these seepage zones.

5.4 SEWER LINES

As part of this investigation, the discharge from three old sewer lines designated as NW-8, NW-10, and NW-11 were sampled at their outfalls along the Hylebos Waterway (Plate 1). The sources of these discharges were not investigated. During the initial field surveys conducted in April 1981, individual samples were collected from each of the three sewer outfalls with an additional sample from NW-10 being collected during the third round of groundwater sampling. The analytical results for these samples has been previously presented in Tables 4-28 and 4-29 of Section 4.

The analytical results for the sewer outfall samples revealed elevated concentrations of arsenic, chromium, and chloroform to be present. Based upon the analytical results and the measured flow rates at the sewer outfalls, the loadings in pounds per day from the sewers would be as follows:

Sewer	Arsenic	Chromium	Chloroform
NW-8	0.72	0.005	0.005
NW-10	4.34	0.002	*
NW-11	1.77	0.001	*

*Analysis not performed (samples lost in lab).

The calculated loadings for chromium and chloroform are very minimal. The calculated arsenic loading from the three sewers represents approximately 86 percent of the total arsenic discharge from the four identified transport pathways. The source of arsenic in these sewers is not exactly known; however, it is possible that it is the result of one, or a combination of the following:

1. Residual penite sludges in the sewer lines.
2. Residual penite in the Penite building (floor drains, etc.)
3. Inflow of contaminated groundwater near the Penite disposal area.

It should be noted that these three sewer lines are currently in the process of being sealed and disconnected which will eliminate or minimize the discharge of contaminants from this source.

5.5 SURFACE RUNOFF

Clearly identifiable surface runoff from the Pennwalt waste management areas was observed and sampled at one location, sample station NW-1. This station represents runoff from the Taylor Lake area which drains toward the northeast corner of the plant property and discharges into the

East drainage ditch approximately 200 ft from the waterway (Plate 1). Runoff from this area represented primarily seepage from the ponds in the Taylor Lake area along with some precipitation following rainfall events.

Samples of runoff were collected at NW-1 prior to discharge to the East drainage ditch during both dry and wet weather conditions. The results of this sampling have been previously presented in Table 4-28 of Section 4. A flow of 3.2 gpm was measured at this station during the sampling program. Based upon the average concentration of the two samples collected at this station and the measured flow of 3.2 gpm, the resultant loadings for arsenic, chloroform, and chromium would be 0.05, 0.23, and 0.01 lb/day, respectively.

The above loading rates indicate that only minimal amounts of contaminants were being discharged to the waterway via surface runoff at the time of sampling. It should be noted that since the use of the Cell Room Pond has been discontinued, the standing water in the vicinity of Taylor Lake is no longer present with no observable continuous surface runoff currently occurring from this area. It is expected that very little runoff will occur from this area as a result of the elimination of the standing water associated with the operation of the Cell Room Pond. In addition, since wastewater discharges containing high concentrations of residual chlorine have been discontinued to the Cell Room Pond, a source of chloroform resulting from the reaction of free chlorine and naturally-occurring organic matter has been eliminated. Therefore, the subsequent loading to the waterway will be significantly lower than the previously observed conditions, and probably eliminated.

5.6 RESULTANT LOADING RATES TO WATERWAY

As previously discussed in this section, the contaminants having the most significant concentrations in the four transport pathways include arsenic, chloroform, and chromium. In order to calculate the approximate concentration in the waterway as a result of these discharges, the following mass balance equation can be utilized:

$$C_R = \frac{Q_H C_H + Q_T C_T}{Q_H + Q_T}$$

where:

C_R = resultant concentration in Hylebos Waterway (mg/l).

Q_H = daily seawater exchange in the Hylebos Waterway (gal/day).

C_H = ambient parameter concentration in the Hylebos Waterway.

Q_T = total quantity discharged from contaminant sources (gal/day).

C_T = parameter concentration in contaminant discharge (mg/l).

The exchange of sea water in the waterway was estimated to be 474 mil gal per tidal cycle or 948 mgd based upon an average 10-ft change in tide elevation. Utilizing the above equation and the previously determined loading rates for the four identified pathways, the resultant concentrations of arsenic, chloroform, and chromium in the Hylebos Waterway would be approximately 0.001, 0.00008, and 0.000006 mg/l, respectively. The loadings and resultant concentrations for chloroform and chromium from the four identified pathways are summarized in Table 5-3 with the total arsenic loading rates and resultant concentrations for these sources being summarized in Table 5-4.

TABLE 5-3

CHLOROFORM AND CHROMIUM LOADING RATES TO HYLEBOS WATERWAY FROM ALL SOURCES

Discharge Source	Concentration[a] (mg/l) Chloroform/Chromium	Flow Rate (gpd)	Loading Rate to Waterway (lb/day) Chloroform/Chromium	Resultant Concentration to Waterway (ppm) Chloroform/Chromium
Surface Runoff				
NW-1	6.0/ 0.47	4,608	0.23/ 0.02	0.00003/0.000003
Seeps				
NW-3	--/ 0.21	360	--/ 0.0006	-- /0.00000007
NW-4	12.2/ 0.49	360	0.04/ 0.001	0.000005/0.0000001
NW-5	34.0/ 0.40	360	0.10/ 0.001	0.00001/0.0000001
NW-7	5.2/ --	1,440	.06/ --	0.000007/ --
Sewers				
NW-8	0.15/0.015	4,320	0.005/ 0.0005	0.0000006/0.0000006
NW-10	--/0.037	6,912	--/ 0.002	--/0.0000002
NW-11	--/0.037	4,320	--/ 0.001	-- /0.0000001
Groundwater				
Shallow Zone	2.2/ 1.97	1,134-1,278/1,008-1,136	0.016 to 0.018/0.017 to 0.019	0.000002/0.000002
Intermediate Zone	4.09/ --	2,480-6,590/ --	0.085 - 0.22/ --	0.00003/ --
Total		18,956/ 23,376	0.67/ 0.05	0.00008/0.000006

[a]Runoff, seep and sewer concentrations from samples collected April 7, 1981; groundwater concentrations are average of all groundwater samples from wells in plume areas.

TABLE 5-4

ARSENIC LOADING RATES TO HYLEBOS WATERWAY
FROM ALL SOURCES

Discharge Source	Concentration (mg/l)	Flow Rate (gpd)	Loading Rate to Waterway (lb/day)	Resultant Concentration To Waterway (ppm)
Surface Runoff				
NW-1	1.24	4,608	0.05	0.000006
Seeps				
NW-3	0.17	360	0.0005	0.00000006
NW-4	0.31	360	0.0009	0.0000001
NW-5	0.04	360	0.0001	0.00000001
Sewers				
NW-8	2.0	4,320	0.72	0.00009
NW-10	75.0	6,912	4.34	0.0005
NW-11	49.0	4,320	1.77	0.0002
Groundwater				
Shallow Zone	[a]	[a]	1.03/ 0.92[a]	0.00013/0.00012
Intermediate Zone	0.26[b]	3,672/1,377[c]	0.008/0.003	0.000001/0.0000004
Total		33,114	7.92	0.001

[a]From Table 5-2.

[b]Average concentration in P-6S

[c]From Table 5-1 and assuming plume width of 300 ft.

As can be seen in Table 5-3, the total loadings for chloroform and chromium from all sources is minimal. As previously discussed in this section, the discharge from surface runoff and seeps along the waterway have been significantly reduced as a result of the discontinuation of discharges to the Cell Room Pond. In addition, the three sewer lines are currently in the process of being sealed and disconnected which should eliminate discharges from this source. Therefore, the future discharge of chloroform and chromium will be significantly reduced from present levels and will result in even lower concentrations in the waterway (Table 5-3).

The loading rates and resultant concentrations for arsenic, shown in Table 5-4, reveal that the major loading of arsenic to the waterway occurs from the three sewer lines. These three sewer lines account for approximately 86 percent of the total arsenic being discharged to the waterway based upon the calculated loadings. As previously mentioned, these sewers are currently in the process of being sealed and disconnected, and the discharges associated with the visual seeps and surface runoff have been significantly reduced. Therefore, the present arsenic loading to the waterway will be substantially reduced.

The results of the mass balance calculations indicate that only a minimal change in the waterway concentration of a given constituent has probably occurred in the past as a result of discharges from the four identified transport pathways at the Pennwalt facility. In addition, these loading rates and resultant concentrations were calculated utilizing conservative input values which should reflect conditions worse than would be expected under prevailing conditions. Due to recent and proposed plant modifications resulting in a substantial decrease in the discharge from the sewers, seeps, and surface runoff at the facility, the current and future loading rates, especially for arsenic, are expected to be significantly less than that identified under previously existing conditions.

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SECTION 6

RECOMMENDATIONS

Based upon the investigations and evaluations conducted as part of this study, the following recommendations are presented:

1. Discontinue operations at the Taylor Lake area and close out the site.
2. Construct new asbestos pond and brine mud pond in the Taylor Lake area.
3. Close out the Wypenn area.
4. Seal the three sewers associated with stations NW-8, NW-10, and NW-11 which have been found to discharge arsenic. These sewers should be sealed and disconnected upgradient from the inactive Penite site. Surface runoff associated with these plugged sewers will be diverted to the plant stormwater system.
5. Implement a groundwater monitoring program to monitor and evaluate the anticipated decreasing trend in contaminant concentrations in the water-bearing zones beneath the facility.